2023-12-01

Traditional And Emerging Modifiable Lifestyle Risk Behaviors For Non-Communicable Diseases In A Sample Of Hispanic/latino American Adolescents Living In The U.S.-Mexico Border Region

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DEDICATION

This work is dedicated to my dear family and friends. To my parents, for instilling in me the values of hard work and perseverance. To my brothers and friends, who have been there with words of encouragement. To my in-laws, for their support and words of wisdom.

Especially to my lovely husband and my dear son, who are my inspiration and the joy of my life.

Thank you all for your unconditional love and support.

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by

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DISSERTATION

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

Interdisciplinary Health Sciences Program

THE UNIVERSITY OF TEXAS AT EL PASO

DECEMBER 2023

ACKNOWLEDGMENTS

I will always be grateful to The University of Texas at El Paso, which has provided me with a unique academic education that will open new possibilities for me and my family. First and foremost, I would like to express my profound gratitude and admiration to my mentor, Dr. Maria Duarte-Gardea, who guided me through this academic journey. I have been truly fortunate to have you as my mentor; your expertise, unwavering support, encouragement, and insightful feedback have shaped the quality and direction of my doctoral research. Thank you for investing time and energy into mentoring me; working under your guidance has enriched my academic experience and contributed to my personal and professional growth.

I would like to express my sincere gratitude to Dr. Cristina Sobin for the opportunities you have provided me, as well as your invaluable support, guidance, and commitment as a member of my dissertation committee. Additionally, I would like to express my immense gratitude to Dr. Julia Lechuga for the expert advice, methodological insights, invaluable support, and guidance you provided me during the multiple imputation process and the subsequent data analysis. Similarly, I would like to express my gratitude to Dr. Craig Field for your support and guidance during the online survey project and your commitment as a member of my dissertation committee. Thank you all once again for all your time and support. It has been an honor working with each of you, and I am more than grateful for the positive impact you have had on my academic and professional development.

Special thanks to Dr. Leah Whigham, whose support meant a lot to me; achieving this academic goal would not have been possible without the opportunities you have fostered for us. Likewise, I would like to acknowledge Dr. Holly Mata and Dr. Joao Ferreira, from whom I have learned to be a better scientist. I am grateful for the guidance provided by Darlene Muguiro and the financial support provided by the Interdisciplinary Health Science Doctoral Program. Lastly, I want to express my deepest appreciation to my family and friends for their unwavering support, understanding, and encouragement during the challenging phases of this doctoral endeavor. This dissertation would not have been possible without the collaborative efforts and support of all those mentioned above. Thank you for being an integral part of this academic milestone.

ABSTRACT

Background: Non-communicable diseases (NCDs) pose a significant global health threat, with modifiable lifestyle risk behaviors (mLRBs) contributing substantially to their onset. This study examined traditional and emerging mLRBs and their distribution on cross-sectional health outcomes among Hispanic/Latino in-school adolescents living on the U.S.-Mexico border.

Methods: This secondary data analysis used information from the cross-sectional 2019 El Paso YHBS obtained through online surveys. The secondary data analyzed the prevalence, clustering, and co-occurrence of mLRBs of 539 Hispanic/Latino high school students. Results were compared to mLRBs findings corresponding to Hispanic/Latino adolescents who participated in the national and state 2019 CDC YRBSS. An adolescent lifestyle risk index and the most common patterns were explored among the local sample of adolescents.

Results: Local adolescents displayed engaging in traditional and emerging mLRBs, with differences found based on sex, grade, and body weight status stratification. Local 9th and 10th grade students slightly outperformed their national and state peers in 6 and 7 mLRBs, respectively. Only a small fraction (5.8%) met the 24-hour movement behaviors concept. Cluster analysis revealed five distinct groups with varying levels of at- risks behaviors based on their engagement with mLRBs. Most local Hispanic/Latino adolescents (97.6%) did not meet one or more of the CDC's mLRB guidelines, with the most prevalent combination (18.4%) being insufficient physical activity, unhealthy diet behaviors, increased screen time, and reduced sleep time.

Conclusion: The study revealed a considerable engagement in both traditional and emerging mLRBs among local Hispanic/Latino adolescents. The relationship between mLRBs and indicators like depression symptoms and low school performance underscores the need for local targeted innovative interventions. With just ~2% not engaging in any mLRBs, the study highlights the urgency for culturally tailored multi-risk behavioral interventions and participatory initiatives to address these traditional and emerging mLRBs and mitigate future health risks in this population.

Key Words: mLRBs, NCDs, Hispanic/Latino, Adolescents.

SUMMARY

Globally, non-communicable diseases (NCDs) are the leading causes of morbidity and mortality. It is estimated that over the next two decades the global economic burden of NCDs will top 47 trillion US dollars. Modifiable lifestyle risk behaviors (mLRBs) associated with NCDs, include traditional factors such as lack of physical activity (PA), unhealthy dietary behaviors (DIET), smoking tobacco (TOB), and alcohol drinking (OH), as well as emerging factors such as increased recreational sedentary behaviors (RSST) and short sleep time (ST). These mLRBs typically commence during adolescence and continue into adulthood, tending to co-occur or cluster together within populations, and their combined presence can exacerbate their adverse health effects beyond their individual impacts.

The factors influencing adolescent lifestyle risk behaviors, which impact their health and well-being, are complex; therefore, data from local health surveys may diverge from nationally representative data. To the best of our knowledge, there is limited surveillance data describing the mLRBs of adolescents living along the U.S.-Mexico border region of El Paso County, Texas, where ~83% of the population is of Hispanics or Latino origin. The Youth Risk Behavior Surveillance System (YRBSS) is the largest nationwide population-based surveillance system that monitors critical behavioral information among high school students. Every other year, the Centers for Disease Control and Prevention (CDC) uses the YRBSS to document the prevalence and trends of health-related behaviors among adolescents at the national, state, territorial, tribal, and local levels. Populations that participate in health surveillance have advantages when compared to un-surveyed populations as specific risk behaviors can be identified and addressed through targeted local interventions. To assess lifestyle risk behaviors among adolescents residing in the U.S.-Mexico border region, a team of researchers conducted a cross-sectional study using "*2019 El Paso Youth Health Behavior Survey* (El Paso YHBS)," that was modeled after the CDC YRBSS survey.

This research project comprises a secondary data analysis to evaluate both traditional and emerging mLRBs associated with the onset of NCDs among Hispanic/Latino adolescents, using data from the 2019 El Paso YHBS cross-sectional study. This project investigated the prevalence, clustering, and co-occurrence of four traditional and two emergent mLRBs in a sample of N=539 Hispanic/Latino high school students (48% female; 52% males) enrolled in the 9th (45%) and 10th (56%) grades. Additionally, these local results were compared to a subset of results from the 2019

CDC YRBSS national and statewide surveillance among Hispanic/Latino adolescents. Furthermore, the impact of incorporating the two emergent mLRBs into the traditional mLRBs model was also examined.

An initial statistical analysis assessed whether participants in the 2019 El Paso YHBS met the CDC recommended standards for traditional and emerging mLRBs. Results revealed that students did not adhere to the health behaviors recommendations for adolescents including inadequate DIET (79%), insufficient PA (70%), use of TOB (23%), consumption of OH (17%) among the traditional mLRBs, and insufficient ST (64%) and increased RSST (63%) among the emergent mLRBs. When stratifying by sex, more female adolescents had reduced PA, insufficient physical education, low milk consumption, not eating breakfast, and reduced ST, while soda consumption was higher among male adolescents (Pearson chi-square test, $p<0.05$). When compared by school grade, a higher percentage of 10^{th} grade students did not participate in physical education, skipped breakfast, and consumed OH compared to 9^{th} graders (Pearson chi-square test, $p<0.05$). When analyzing the data based on weight status, it was found that, paradoxically, soda consumption was higher among students who were not overweight or obese (Pearson chi-square test, $p<0.05$).

A comparison with the 2019 CDC YRBSS data showed that local students had similar health risk behavior trends as their state and national counterparts and did not meet all the CDC recommended standards for modifiable risk behaviors. Nonetheless, compared to national and state averages, local 9^{th} grade Hispanic/Latino students showed lowest percentages of not meeting the mLRBs, specifically for insufficient PA, no milk and breakfast intake, consumption of OH, and insufficient ST (one-sided Binomial-Test, $p<0.05$). Conversely, local 9^{th} grade students were more likely to not consume vegetables, when compared to the state and national data (one-sided Binomial-Test, $p<0.05$). Furthermore, among 10^{th} grade Hispanic/Latino adolescents, local students showed the lowest percentages of not meeting PA, insufficient PE, no milk intake, skipping breakfast, soda or OH consumption, and insufficient ST than state and national averages (one-sided Binomial-Test, $p<0.05$). Additionally, local 9^{th} and 10^{th} grade students were more likely to use TOB products that their state peers but less likely than their national peers (one-sided Binomial-Test, $p<0.05$).

Regarding meeting the evidence-based 24-hour movement behaviors (24-MBs) concept, results showed among our sample (n =531) that 30.4% meet PA, 37.4% RSST, and 35.8% meet

ST recommendations. Overall, only 5.8% of the participants met the three 24-MBs guidelines and when the sample was stratified by sex, the difference was statistically significant between males (8.7%, 95% CI 5.37 – 12.03) and females (2.7%, 95% CI 0.71 – 4.68) (Pearson Chi-Square-Test (1, N=531) = 8.662, p= 0.003). Moreover, the achieved 5.8% (95% CI, 4.0, 8.2) of our local sample was higher than the national average for Hispanic/Latino of 4.0% (95% CI, 3.5, 4.4) meeting the 24-MBs guidelines reported by (Knell et al., 2019) (One-Sample Binomial Test, p= 0.025). Furthermore, the local males had a significantly higher percentage of 8.7% (95% CI, 5.37 – 12.03) meeting the 24-MBs concept compared to the reported national value for Hispanic/Latino males of 5.4% (95% CI, 4.7, 6.1) by (Knell et al., 2019) (One-Sample Binomial Test, p= 0.015).

To identify the co-occurrence of traditional and emerging mLRBs, a two-step cluster (TSC) analysis was conducted on both the original dataset (n = 454) and a newly generated imputed dataset (n = 539), with consistent results from both datasets. The TCS analysis revealed five well-defined clusters with a fair silhouette coefficient of 0.4, identified groups varying from relatively healthy to unhealthy, and labeled according to the number of mLRBs marked as at risk. Among these clusters, the cluster labeled as “2 mLRBs” exhibited the fewest behaviors marked as at-risk and accounted for 18.6% (100) of the sample and was considered the lowest health risk group. This was followed by the "3 mLRBs-T" cluster comprising 13.7% (74) of the participants, “3 mLRBs-E” 15.0% (81), “4 mLRBs” 27.3% (147), and lastly “6 mLRBs” comprising 25.4% (137) of the adolescents; this last one being considered as the highest health risk group since it had all 6 behaviors marked as at-risk. Additionally, it was observed that half of the sample (~52%) were grouped into cluster 4 mLRBs (high health risk) or 6 mLRBs (highest health risk), the two least healthy patterns or most unfavorable lifestyles.

Finally, to explore whether the inclusion of the two emerging mLRBs (RSST and ST) had an impact on the classification of cross-sectional outcomes, a traditional index score and an emergent index score were computed based on the students’ engagement with mLRBs. Overall, an initial index score (range 0-4) was calculated based on the students’ engagement with any of the four traditional mLRBs. It was observed that 8% of the students reported not engaging in any "at-risk" behaviors, 26%, 45%, 13%, and 9% engaged in one, two, three, and all four traditional mLRB, respectively. Moreover, it was observed that the higher the number of traditional mLRBs in students, the higher the occurrence of RSST and ST emerging mLRBs. Furthermore, adding the two emergent to the four traditional mLRBs index (range 0-6), it was observed that only 2% of the

adolescents did not engage in any "at-risk" behaviors. Additionally, 9% engaged with one, and 20%, 29%, 25%, 10%, and 5% respectively reported engagement with two, three, four, five, and six mLRBs.

The inclusion of the two emerging mLRBs into the traditional mLRB index did not lead to an improvement in the prediction of the cross-sectional outcome of body weight status. Similarly, when predicting low school performance, the basic model including the traditional mLRBs index achieved a prediction percentage of 79.4% ($p<0.001$) and the addition of the two emerging mLRBs did not result in any improvement in prediction. On the contrary, incorporating both emerging mLRBs into the traditional index slightly improved the prediction by 2% for the cross-sectional outcome of a symptom of depression. The basic model including the traditional mLRBs index had a prediction percentage of 67.2% ($p<0.001$), while the final model including all traditional and emergent mLRBs showed a prediction of 69.2% ($p<0.001$). Lastly, the most prevalent unique combination without repetition using these six mLRBs was with four risk behaviors: insufficient PA + inadequate DIET + increased RSST + insufficient ST. This unique combination accounted for 18.37% of our local sample.

In conclusion, the results of this study indicate that our local sample of Hispanic/Latino in-school adolescents living in El Paso County, Texas along the U.S.-Mexico border region, actively engaged in both traditional and emerging mLRBs, all of which are associated with the development of NCDs later in life. In addition, there was a clear trend between the number of mLRBs among adolescents experiencing depression symptoms and reporting low school performance. The clustering of various mLRB combinations indicates the potential for innovative approaches and strategies to tackle NCD prevention. With only 2% of the adolescents in our sample not engaging in any mLRBs, the results of this study suggest the need for locally tailored lifestyle interventions addressing traditional and emerging mLRBs along with adolescent participatory initiatives aimed at mitigating the potential adverse health outcomes in their adulthood.

Knell, G., Durand, C. P., Kohl, H. W., Wu, I. H. C., & Gabriel, K. P. (2019). Prevalence and likelihood of meeting sleep, physical activity, and screen-time guidelines among US youth. *JAMA pediatrics*, *173*(4), 387-389.

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BMI	Body Mass Index
CDC	Center for Disease Control and Prevention
DALY	Disability-Adjusted Life Years
DIET	Not meeting at least three out of the five dietary recommendations (i.e., fruit, vegetables, milk, breakfast, and soda) in the past week.
HP	Healthy People 2030
mLRBs	Modifiable Lifestyle Risk Behaviors
MVPA	Moderate to Vigorous Physical Activity
NCDs	Non-Communicable Diseases
NWS	Nutrition and Weight Status
OH	Consuming at least one alcoholic beverage in the past 30 days
PA	Did not engage in at least 60 minutes of physical activity daily for seven days.
RSST	Spent three or more hours engaging in recreational sedentary screen time on an average school day for non-school purposes.
SDG	Sustainable Development Goals from the United Nations
ST	Had seven or fewer hours of sleep time on an average school night.
TOB	Using any tobacco products in the past 30 days.
TSC	Two-step cluster
U.S.	United States
WHO	World Health Organization
YHBS	El Paso Youth Health Behavior Survey
YRBSS	Youth Risk Behavior Surveillance System
24-MBs	24-hour movement behaviors

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1. History of Adolescent Health

At the beginning of the last century, the understanding of adolescent health was in its infancy. In 1904, Stanley Hall, president of the American Psychological Association, is credited to attribute the already existing word adolescence (i.e., from Latin, "to grow into maturity") to a phase in human developmental (Hall, 1905). In the 1930s some of the first publications on the topic of adolescence only described the physiological changes in boys and girls that reached puberty (Alderman et al., 2003; Stuart, 1946). In the 1950s, scholars found that X-rays were an excellent tool to determine physiological age and diagnose bone abnormalities in adolescents (Acheson et al., 1966).

It wasn't until the 1970s, that Boyar et al. (1976) and Zumoff et al. (1976) discovered that hormonal events (e.g., estradiol and testosterone secretion in girls and boys, respectively) triggered the physical changes of puberty (Boyar et al., 1976; Zumoff et al., 1976). Furthermore, the scholars determined that an increase in growth hormone during early adolescence was a unique marker for puberty identification (Boyar et al., 1972). These results helped to differentiate childhood from adolescence.

From a behavioral perspective, Elkind (1984) postulated that adolescents have a tendency to believe they are always being watched and evaluated by others (i.e., imaginary audience concept) but also have a belief of uniqueness and invulnerability (i.e., personal fable concept). Hence, the author concluded that adolescents are particularly susceptible to social pressures, drug use, and sexual activity (Elkind, 1984).

Additionally, behavioral and psychological data helped differentiate middle and late adolescence from adulthood (Alderman et al., 2003). Adolescence is currently classified as a phase of human development between the ages of ten and nineteen years (Sacks et al., 2003), a

time of physiological changes and neural plasticity (Holder & Blaustein, 2014). Adolescence development is divided into three stages: early adolescence from 11-14 years, middle from 15-17 years, and late adolescence from 18 to 21 years of age.

The principal expected task of adolescents is to prepare for adulthood. Globalization, new technologies, and changes in society due to the difference in circumstances and cultural systems have different effects on adolescents' preparation for adulthood worldwide. For instance, in the United States (U.S.), low-income adolescents arrive at adulthood in a worst health status when compared to their more affluent counterparts (Escarce, 2003), and adolescents from South Asia and Arabic countries are less influenced by peers when compared to adolescents from western countries (Brown et al., 2002).

Due to the educational level and skillset needed to enter adulthood, most modern societies are in support of an extended period of the adolescent stage. For instance, there are reports indicating that in rural India the average age of marriage and primary employment has been increased from 12 to 16 years and from 22 to 26 years in Europe or North America (Arnett, 2000).

Current trends in globalization and its economic and technological changes have a strong influence on adolescents' lifestyle from developed and developing countries. These complex effects on society may not necessarily be beneficial for adolescent health (Larson, 2002). In 2002, Larson acknowledged that economic globalization has benefits for adolescents and children in wealthy countries while adolescents living in poverty in other regions are left behind (Larson, 2002).

1.1.1. Adolescent Health in Global and National Health Agendas

The sustainability of healthy behaviors throughout different stages of life, including adolescence and adulthood, may result in healthy generations for years to come. In order to sustain health, it is important to identify and act on factors that predispose adolescents to adopt healthy behaviors and place those at the center of global and national health agendas.

A 2018 report from the World Health Organization (WHO) "Saving lives, spending less", has shown that scaling up investments in non-communicable diseases (NCDs) prevention and opportune treatment can lead to achieve major health benefits, save lives, and boost economic growth (WHO, 2018b). Given today's adolescent population at 1.2 billion worldwide and 42 million in the U.S. (UNICEF, 2019; US_Census, 2020), attention to this age group is of utmost significance given the fact that adolescent unhealthy behaviors can be carried into adulthood with its related health risk and outcomes.

The importance of adolescent health has been recognized by governments and has now been included as specific goals in global and national health agendas. For instance, the United Nations Sustainable Development Goals (SDG) agenda "Ensure healthy lives and promote well-being for all ages," has included adolescent health as a key objective to be achieved by 2030. Particularly, SDG target 3.4 is to reduce premature mortality from NCDs by one third through prevention and health promotion (SDGs_UN, 2020).

Recognizing that many behaviors that can affect health and well-being later in life start during adolescence, Healthy People (HP) 2030 has included adolescent objectives to help guide them to stay safe and healthy (HP2030, 2020). To this end, there are 100 objectives that have been included within this goal. For instance, objective Nutrition and Weight Status-10 (NWS-10) aims at reducing consumption of added sugars by people aged 2 and over; objective Physical

Activity-07 (PA-07) aims at increasing the proportion of adolescents who do enough aerobic exercise; objective Tobacco Use-04 (TU-04) aims at reducing current tobacco use in adolescents; objective Substance Use-04 (SU-04) aims at reducing the proportion of adolescents who drank alcohol in the past month; objective Physical Activity-Research-02 (PA-R02) aims at increasing the proportion of parents who follow American Academy of Pediatrics recommendations on limiting screen time for children aged 6 to 17 years; objective Sleep Health-04 (SH-04) aims at increasing the proportion of high school students who get enough sleep; and objective Nutrition and Weight Status-04 (NWS-04) aims at reducing the proportion of children and adolescent with obesity. Overall, the focus of HP 2030 is to support young people to achieve optimal development and well-being while avoiding behaviors that can lead to acute and chronic health conditions (HP2030, 2020).

1.1.2. Adolescent Population in the United States

According to census data, in 2019, there were 41,852,838 people aged 10-19 years, an estimate that represents 13% of the total U.S. population (US_Census, 2020). Census data also reports that about 51% (21.37 million) are males and 49% (20.49 million) are females. As noted in Figure 1.1, race/ethnic diversity in youth differs from that of the U.S. total population. In 2018, the youth population was 50% white, 25% Hispanic or Latino, 14% Black or African American, 5% Asian, 4% multi-racial, 1% American Indian or Native Alaskan, and less than 0.5% Native Hawaiian or other Pacific Islander (CASEY_FOUNDATION, 2020).

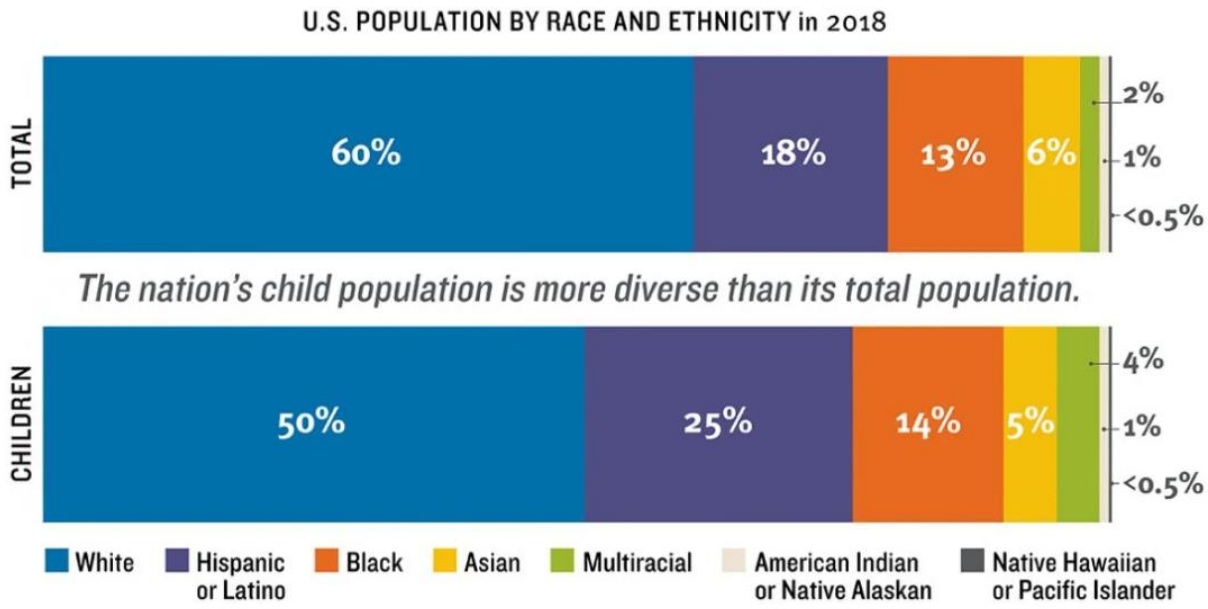

Figure 1.1. Distribution of race/ethnicity in the U.S. total and youth population (CASEY_FOUNDATION, 2020).

Studies have shown that similar to adults, there are health disparities within the adolescent population. Health disparities are associated with the uneven distribution of economic, political, social, and environmental resources (CDC, 2020b). Health disparities can be caused by multiple factors including poverty, educational inequalities, environmental factors, inadequate access to health care, behavioral factors, etc. Population health is influenced by multiple and complex levels of factors (Figure 1.2) and although genetics cause or increases the risk for some diseases, social and environmental determinants such as where an individual was born, where they live, their education access, environmental pollution, socioeconomic status, behaviors, etc., play an integral part of a person's health (CDC, 2019b).

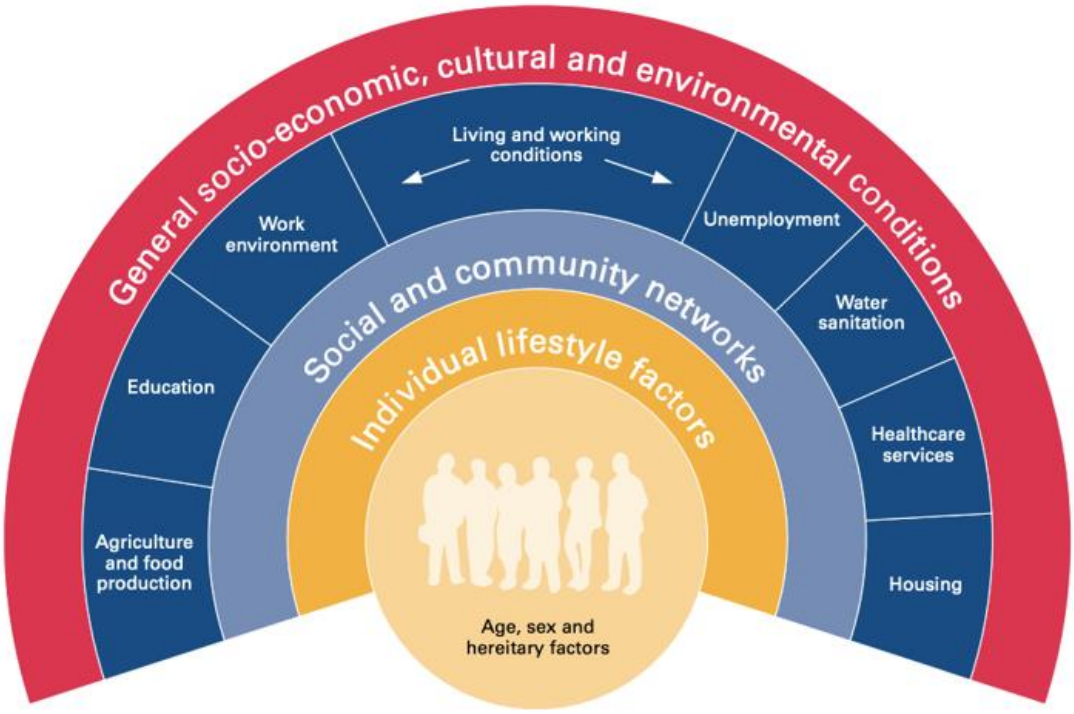

Figure 1.2. Factors that influence a person's health and wellbeing (Williams, 2021).

The dissimilar prevalence of overweight and obesity in adolescents and adults from different ethnicities is an example of a health disparity in a population. Lau et al., (2012) examined racial/ethnic disparities among U.S. adolescents and reported that Hispanics, African Americans, and American Indian/Alaskan Native had greater probabilities than non-Hispanic whites of being overweight/obese and having asthma (Lau et al., 2012). In 2019, the Center for Disease Control and Prevention (CDC) reported that Hispanic (19.6%) adolescents had a higher incidence of overweight when compared to African Americans (16.4%) and non-Hispanic white (14.6%) (CDC, 2020c). Modifiable lifestyle health risk behaviors (mLRBs) are concrete markers that can be measured and quantified in a population, which in turn can be used by stakeholders to monitor and help close the gap in racial/ethnic health disparities by designing and implementing culturally appropriate public health interventions for target populations.

1.2. Adolescence and Non-Communicable Diseases (NCDs)

According to the Center for Disease Control and Prevention (CDC), in 2021, young adults (15-24 years old) had the lowest mortality rates (i.e., 88.9 per 100 000) when compared to older groups. (Xu J Fau - Murphy et al.) Similarly, the per capita health care spending among youth (i.e., $4,217) was the lowest among all age groups (Services, 2020). Based on low mortality rates, low incidence of disease, and low use of health services, overall, this age group has been considered healthy. Although even these low mortality rates are of concern. In 2017, the World Health Organization (WHO) stated that globally, most of the top causes of adolescent mortality are preventable. In the U.S., adolescent mortality is also an important public health concern given that the top three causes of death among this group include accidents, suicide, and homicide, all of these being preventable (CDC, 2019a). In addition, adolescence is a period in the youth's life when behavioral choices that impact health (e.g., unhealthy dietary behaviors, physical inactivity, risky sexual health behaviors, etc.) are established and can be extended into adulthood.

In 1961, Dr. William Kannel, one of the pioneers in the Framingham Heart Study, coined the term "risk factor" (Stampfer et al., 2004; Tsao & Vasan, 2015). Risk factors for non-communicable diseases (NCDs) or chronic diseases, were based on epidemiological methods originally developed for infectious diseases and nutritional deficiencies. NCDs are conditions that last one year or more, require ongoing medical attention, might limit activities of the individual's daily living, and are the result of a combination of genetics, physiological, environmental, and behavioral factors (WHO, 2021). Each year, NCDs cause more than 41 million deaths worldwide (71% of all deaths globally), and 15 million of these deaths occur

prematurely among adults aged 30 to 69 years, age in which their economic productivity is at its pick (WHO, 2021).

Table 1.1. Total deaths and DALYs caused by NCDs (modified from (Chen et al., 2018).

Country group	% of total deaths caused by NCDs			% of total DALYs caused by NCDs		
	1990	2000	2016	1990	2000	2016
Global	58	62	72	44	79	61
High SDI countries	88	89	89	82	84	86
United States	87	88	89	81	83	85
High-middle SDI countries	80	83	87	67	73	79
Middle SDI countries	64	72	80	52	61	73
Low-middle SDI countries	37	42	58	29	34	50
Low SDI countries	25	26	38	19	21	32

*SDI (Sociodemographic Index) is a summary measure of geography's sociodemographic development based on average income per person, educational attainment, and total fertility rate created by the Institute for Health Metrics and Evaluation (IHME).

Mortality or total deaths do not provide a complete picture of the burden of disease. The overall disease burden in different populations is assessed using a time-based measurement known as disability-adjusted life years (DALY). One DALY represents the loss of the equivalent of one year of life at full health. The reported percentages of total deaths and DALYs caused by NCDs in regions, at different phases of sociodemographic development (Table 1.1), shows how since 1990 NCDs growing trend affects all countries; especially those with high sociodemographic index (Chen et al., 2018).

Worldwide, the four groups of NCDs that account for 80% of all premature deaths are, cardiovascular diseases (CVDs) (17.9 million people annually), followed by cancer (9.3 million), respiratory diseases (4.1 million), and diabetes (1.5 million) (WHO, 2021). In the Region of the Americas the probability of premature death (30-70 years) due to a main NCD is 14% (16.4% for males; 11.8% for females) (Pan American Health, 2019). In the U.S., six in ten adults have a

chronic disease and four in ten have two or more of these conditions (CDC, 2021b); and NCDs account for 88% of all deaths in the country (WHO, 2018a).

1.2.1. Modifiable Lifestyle Risk Behaviors (mLRBs)

Adolescence is often an understudied population and a crucial period in life where modifiable risk behaviors associated with an increased risk for NCDs are initiated. According to Bundy et al. (2018), there is a bias in the research on adolescent health given that a large majority of publications (99% and 95% in Google Scholar and PubMed, respectively) have focused on children under 5 years of age (Bundy et al., 2018). Bundy's study reports great advances in reducing mortality in children under 5 years of age; at the same time, it also addresses the importance of studying adolescents, as this population has great potential to improve health outcomes for both youth and adults.

Currently, NCDs impose a substantial economic burden. According to Thow et al. (2022), it is projected that over the next two decades expenses associated with NCDs will reach $47 trillion in U.S. alone (Thow et al., 2022). People of all ages are vulnerable to those behavioral factors associated with the development of NCDs, also known as health risk factors or health risk behaviors (CDC, 2021b; WHO, 2021). In terms of health and economy, this large dollar projection provides a clear reasoning and justification for tackling NCDs and related health risk behaviors among the youth.

1.2.2. Traditional modifiable Lifestyle Risk Behaviors (mLRBs)

Traditionally, there are four health risk factors (behavioral choices) associated with increased morbidity and mortality from NCDs: physical inactivity, unhealthy dietary behaviors, tobacco use, and harmful use of alcohol (Collaborators, 2016). There is ample evidence that the "big four" or traditional health risk behaviors are the precursors of biological and metabolic

changes (e.g., overweight/obesity, hypertension, pre-diabetes, and hyperlipidemia) and when left untreated, these factors will jeopardize individual's health and contribute to the onset of NCDs. Hence, a large proportion of the burden of NCDs could be prevented by modification of traditional health risk behaviors (WHO, 2021).

Physical Inactivity is a key risk factor for the development of NCDs and one of the current major public health concerns (Kohl et al., 2012; Santos et al., 2023). Globally, it is estimated that about 6-10% of all deaths are attributed to physical inactivity and there is evidence showing that this unhealthy behavior increases the risk for NCDs (Ozemek et al., 2019). In addition to contributing to premature morbidity and mortality, the burden of physical inactivity is greatest in high-income countries and responsible for a substantial economic burden (Ding et al., 2016; Katzmarzyk et al., 2022; Lee et al., 2012).

Unhealthy Dietary Behaviors are a modifiable risk factor associated with metabolic changes (abdominal obesity, hypertension, dyslipidemia, and hyperglycemia) that increase the risk of developing NCDs (Alberti et al., 2005; CDC, 2021a). Consumption of processed foods and sugar-sweetened beverages with high caloric content has been linked to weight gain, CVD risk, type 2 diabetes, non-fatty liver disease, and dental cavities (Davis et al., 2005; de Ruyter et al., 2012; Imamura et al., 2015; Jin et al., 2012; Marshall et al., 2003; Welsh et al., 2011). Similarly, inadequate milk and dairy products intake may adversely affect growth, development and increased the risk of developing metabolic syndrome (G.-C. Chen et al., 2015; Dror & Allen, 2014; Dugan & Fernandez, 2014) Likewise, a reduced consumption of fruit and vegetables has been linked to poor health and increased risk for NCDs and all-cause mortality (Aune et al., 2017; Hartley et al., 2013; Schwingshackl et al., 2017).

Tobacco Use. According to Mahapatra & Gaurav (2019), tobacco kills half of its users (Mahapatra & Gaurav, 2019). Every year, the direct use of tobacco accounts for over 7.2 million deaths and exposure to second-hand smoke results in approximately 1.2 million deaths (WHO, 2020b). Tobacco use is a common and highly dangerous behavior that vastly increases the risk of dying from NCDs. Tobacco smoke contains at least 69 carcinogens, harms every organ of the body, and its effects also spread beyond the smoker. E-cigarettes include e-hookahs, mods, vape pens, vape etc. and usually contain less harmful chemicals than smoke from combustion of tobacco products; however, they can contain nicotine and cancer causing chemicals (McCarthy, 2016). Use and addiction of tobacco often begin during adolescence (Arrazola et al., 2015). Smoking has been linked to cancer, lung diseases, heart disease, stroke, type 2 diabetes, and other chronic health conditions (Lushniak et al., 2014; Mokdad et al., 2004; Roderick et al., 2019; Thun et al., 2002; US_HHS, 2014).

Alcohol Consumption reduces self-control among adolescents and is related to injuries (e.g., traffic accidents, violence, etc.), as well as increased engagement in other risky behaviors (e.g., unsafe sex, DUI, etc.). Globally, alcohol consumption is the third leading risk factor for poor health, and it is estimated that it causes more than 10% of NCDs. Evidence has shown an association of alcohol consumption with hypertension, ischemic heart disease, ischemic and hemorrhagic stroke, several types of cancer, pancreatitis, and liver cirrhosis (Alpert et al., 2022; Bagnardi et al., 2015; Parry et al., 2011; Rehm et al., 2018; WHO, 2019; World Health, 2019).

1.2.3. Emerging modifiable Lifestyle Risk Behaviors (mLRBs)

In addition, new evidence suggests that other risk factors such as unhealthy sleep periods and prolonged sitting also have a synergetic effect with the traditional risk factors and contribute to adverse health effects (Ding et al., 2015; Mewton et al., 2019).

Sedentary Behavior is characterized as any behavior with low energy expenditure (less than 1.5 metabolic equivalent units (METs)) while sitting, reclining, or lying posture (Tremblay et al., 2017). Current studies on physical activity use the term "inactivity" as the absence of moderate to vigorous physical activity (MVPA), which fails to differentiate it from too much sitting/lying behavior or leisure time (i.e., television viewing, computer use-screen time, desk-bound work, etc.). Lately, sedentary behavior among adolescents has increased through the frequent use of screens for education and recreation. Emerging evidence is accumulating regarding sedentary behavior's association and causation of adverse health outcomes. Available evidence shows that higher amounts of this particular risk behavior, independent of meeting recommended levels of physical activity, is associated with poor health outcomes, including weight gain, metabolic syndrome, CVD, type 2 diabetes, cancer, and premature mortality (Chau et al., 2013; Edwardson et al., 2012; WHO, 2020a; Wilmot et al., 2012; Young et al., 2016).

Unhealthy Sleep pattern has been associated with adverse health outcomes and is also becoming a health concern (Shang et al., 2020). The recommended hours of sleep for adolescents are 8 to 10 hours per night, according to the American Academy of Sleep Medicine (Paruthi et al., 2016). The prevalence of inadequate sleep is substantially increasing (Hillman et al., 2018). Sleep deprivation and sleep disorders have an adverse effect on physical and mental health (AlDabal & BaHammam, 2011; Filip et al., 2017). Increased evidence shows that insufficient sleep has been linked to obesity, cardiovascular disease, atherosclerosis, hypertension, metabolic syndrome diabetes, depression, and premature total mortality (Buxton & Marcelli, 2010; Cappuccio et al., 2011; Cappuccio et al., 2010; Cappuccio et al., 2008; X. Chen et al., 2015; Gangwisch, 2014; Gangwisch et al., 2007; Jean-Louis et al., 2014; Zhai et al., 2015).

Although manifestation and diagnosis of NCDs rarely unfold before adulthood, traditional and emerging mLRBs are often initiated early in life. According to the National Center for Health Statistics (2017), approximately 70% of premature deaths in adults are due to risk behaviors that began during adolescence (CDC, 2017). In addition, in many countries there are public health concerns due to the high prevalence of several modifiable unhealthy risk behaviors in the population (Chen et al., 2018; Nowbar et al., 2019; Pilapil & DeLaet, 2015; Ramo et al., 2020).

The estimates for morbidity, mortality and the implication for adult health outcomes provide a strong argument to understand determinants of health such as modifiable behavioral risk factors for NCDs. Documenting behavioral risk factors in the everyday life of adolescents can result in evidence-based health initiatives that can protect adolescent health and its extension to adult health and beyond.

1.2.4. Adolescent Health and the Interplay of Obesity, Mental Health & School Performance

Adolescent obesity is a global health problem and a growing concern that affects youth in low, middle, and high-income countries (Abarca-Gómez et al., 2017). In addition to the reduction of quality of life and life expectancy (Grover et al., 2015; Taylor et al., 2013), overweight and obesity are predisposing factors associated with an elevated risk of several major NCDs, including CVD, liver and kidney diseases, dyslipidemia (unhealthy blood levels of lipids), type 2 diabetes, asthma, and certain types of cancer (Loprinzi et al., 2015; Mozaffarian et al., 2015; Nyberg et al., 2018; St et al., 2018). The harmful health consequences of weight gain extend from the non-fatal reduction of quality of life to the increased risk of premature death (Prospective Studies, 2009). In addition, the economic impact associated with overweight and

obesity for a country is significant; the direct medical cost of obesity in the US per year is 260.6 billion dollars (Cawley et al., 2021).

It is estimated that the prevalence of obesity in the U.S. was 42.5% for adults (aged > 19 years) and 21.2% for youth (aged 12-19) in 2017-2018 (CDC, 2018). In high-income countries, disadvantaged adolescents have an increased prevalence of obesity compared to their peers with higher socioeconomic strata (Chung et al., 2016). In addition, 90% of adolescents with obesity will maintain this condition into adulthood (Patton et al., 2011). Cognitive abilities modulated by the prefrontal cortex, such as risk/benefit assessment or the ability to delay immediate gratification for future gain, develop until late adolescence or early adulthood (Shulman et al., 2016). This physiological development has important implications for the management of adolescent obesity and other health risk factors.

The adoption of health-related behaviors is associated with cardiovascular disease and mortality risk reduction (Beccuti & Pannain, 2011). Recent studies have demonstrated that a healthy lifestyle that combines behaviors such as regular exercise, proper nutrition, adequate sleep time, moderate alcohol consumption, and avoidance of tobacco decreases the risk for obesity and reduces or delays the onset of NCDs such as cardiovascular disease, ischemic stroke, type 2 diabetes, as well as some specific cancers (Beccuti & Pannain, 2011; Cerf, 2021).

In addition, good mental health begins early in life, and while healthy lifestyle behaviors cannot guarantee the prevention or treatment of depression, they are recognized as positive factors that support mental well-being. Approximately 3.2% of children and adolescents in the U.S. experience depression (Ghandour et al., 2019). Depression is a prevalent mental health disorder characterized by persistent feelings of sadness, hopelessness, and a loss of interest or pleasure in daily activities (American Psychiatric Association & American Psychiatric, 2013). If

left unaddressed, depression can lead to a variety of cognitive and emotional impairments, significantly impacting one's overall functioning and quality of life.

Also, there is a positive association between sedentary behavior (Huang et al., 2020), high glycemic index (Gangwisch et al., 2015), alcohol consumption (Haynes et al., 2005), and tobacco (Flensborg-Madsen et al., 2011) with the risk of depression. A study of Australian adolescents found that for males, physical inactivity and unhealthy dietary patterns were associated with depressive symptoms, while screen time was associated with depression in females (Hayward et al., 2016). The association between mLRBs and depression suggests that interventions could be targeted to reduce depression symptoms.

Moreover, depression can significantly impede a student's ability to excel academically, as it may result in poor concentration, decreased motivation, and impaired problem-solving skills (Fröjd et al., 2008; Riglin et al., 2014; Wickersham et al., 2021). According to a research study, the prevalence of depression tends to rise as students transition from childhood (ages 6−11 years), where it is at 1.7%, to adolescence (ages 12−17 years), where the prevalence increases to 6.1% (Ghandour et al., 2019); a critical period of development that is marked by important educational milestones.

There is a growing body of research that highlights the interconnectedness between school performance and obesity. The prevalence of overweight and obesity among school-aged children is a public health concern with profound implications for academic achievement (Skinner et al., 2018). Overweight and obese students may face social stigmatization, physical health issues, and reduced self-esteem, all of which can negatively impact their educational outcomes, such as lower test scores, absenteeism, and reduced cognitive function (Carey et al., 2015; Devaux & Vuik, 2019). These complex connections and intricate relationships underscore

the importance of addressing both mental health and obesity issues within the educational context, with potential implications for preventive interventions and support services.

1.3. Health Interventions and Public Health Surveillance Systems

In 1988, a report from the committee of the Institute of Medicine emphasized "assessment" as one of the three core functions of public health along with assurance and policy development (Institute of Medicine . Committee for the Study of the Future of Public, 1988). Public health assessment or surveillance is the constant and methodical gathering, examination, and interpretation of health data. One of the first surveillance can be traced to 1741 in Rhode Island when an act required taverns to inform about infectious diseases among their customers. (Thacker et al., 2012)

In the United States, there are several surveys that monitor the risk health behaviors and concomitant health outcomes in populations. These surveys provide critical data for public health research, monitoring of health trends and policy development. The information collected helps researchers and health government agencies to understand and address health risk behaviors and improve public health outcomes. Examples of national surveys include the Behavioral Risk Factor Surveillance System (BRFSS) , National Health and Nutrition Examination Survey (NHNES), The National Survey on Drug Use and Health (NSDUH), the National Survey on Family Growth (NSFG), The Youth Tobacco Survey (YTS), The National Immunization Survey (NIS) and the Youth Risk Behavior Surveillance System (YRBSS) (Williams et al., 2018).

The CDC describes four steps as the public health approach to challenge diseases and viruses. They are surveillance (i.e., identifies if there is a public health problem), risk factor identification (i.e., what is the cause of the problem), intervention evaluation (i.e., what solution can be introduced), and implementation (i.e., how the solution can be best implemented)

(Markovic, 2012). Public health interventions are organized efforts to promote or discourage behaviors that have an effect on the physical, mental and emotional health of the population.

One example is the North Karelia Project. In 1970 North Karelia, a province in Finland had reported an extremely high mortality due to CVD among its middle-age population. To address this this health problem, the government launched a comprehensive community targeted intervention to reduce specific risk factors (high cholesterol, smoking, and high blood pressure levels). Results of this intervention were encouraging given that coronary mortality was reduced by 84% from 1972 to 2014 mainly due to lifestyle risk factor changes (Vartiainen, 2018).

Similarly in 2002, in Alaska, due to the historically high tobacco use, the U.S. the Department of Health and Social Services implemented a comprehensive tobacco control program. Results from this tobacco control program were visible in the 2008 Alaska Behavioral Risk Factor Surveillance System, where data showed an important reduction in tobacco use. There was a 40% reduction of smokers as a result of this comprehensive intervention representing approximately 8,000 fewer tobacco-related deaths and a 300 million dollars savings in medical costs (HealthyAmericans, 2009).

These two interventions demonstrate that public health surveillance provides valuable information that allows the evaluation of the burden and distribution of determinants of health. Modern public health uses surveillance data that provide guidance for the design and impact of health interventions and allows to prioritize action plans (Groseclose & Buckeridge, 2017).

1.3.1. National CDC Youth Risk Behavior Surveillance System (YRBSS)

In 1990, the Center for Disease Control and Prevention developed and implemented a national cross-sectional, biennial school-based survey to monitor potential health risk behaviors among adolescents in the U.S. Among students in grades 9^{th} – 12^{th} who attend public and private

schools, the CDC's Youth Risk Behavior Surveillance System (YRBSS) monitors health-related behaviors, including: 1) unhealthy dietary behaviors, 2) inadequate physical activity, 3) behaviors that contribute to unintentional injuries and violence, 4) sexual behaviors related to unintended pregnancy and sexually transmitted diseases, including HIV infection, 5) alcohol and other drug use, and 6) tobacco use (CDC, 2018).

The CDC's YRBSS provides statistics representative of students in grades 9–12 attending U.S. high schools. The National CDC YRBSS data sources include ongoing surveys, one-time national surveys, special population surveys and method studies. The surveys include school-based national, state, tribal and large urban school district surveys of representative samples of high school students and in some site's representative surveys of middle school students (Brener et al., 2013). The surveys are implemented on an ongoing basis and are conducted biennially. Each cycle begins in July for the preceding even-numbered year (e.g., in 2010 for the 2011 cycle), and data are published in June of the following even-numbered year (e.g., in 2012 for the 2011 cycle). The CDC's YRBSS is the best source of quality data to monitor health behaviors at the national, state, territorial, and local school district levels. YRBSS uses weighted estimates based on student sex, race/ethnicity, and grade that are national representatives of public and private schools for grades 9-12 and only if the surveys have an overall response rate of >60% (Underwood et al., 2020). The CDC YRBSS methodology has been published previously (Brener et al., 2013).

During the 2019 National CDC YRBSS a total of 13,677 usable questionnaires were completed in 136 schools (Underwood et al., 2020). Results from the 2017 National CDC YRBSS showed that 19.2% of Hispanic high school students were obese, a higher number when compared to the mean (15.5 %), and Non-Hispanic White students (13.1%) (CDC, 2019b). The

results also showed a lower percentage of physical activity in Hispanic students (39.9%) when compared to their peers (44.1%). In terms of vegetable consumption, when compared to their non-Hispanic White peers (5.3%), more African American students (12.7%) and Hispanic students (9.2%) reported not eating vegetables (CDC, 2019b).

The results of the 2019 National CDC YRBSS also showed differences in the prevalence of dangerous behavior based on race/ethnicity. For example, it was shown that Hispanic adolescents had a higher prevalence of drinking and driving (6.6%) when compared to African Americans (4.1%) and non-Hispanic Whites (5.1%) (CDC, 2019b). Similarly, results on sexual behaviors related to unintended pregnancy and sexually transmitted diseases have also shown disparities in the population; however, the literature also shows a growing number of national and state programs aimed at reducing the prevalence of the risk factors. In another indicator, Martin et al. (2013) reported that Hispanic and African American adolescents' birth rates are double the rate of non-Hispanic Whites in the U.S. The authors attributed the disproportion to the socioeconomic disadvantage of the populations (Martin et al., 2013).

Efforts to counteract health risk behaviors identified through national surveys consist of targeted interventions. For example, in 2015 Manlove et al. (2015) identified and evaluated 103 sexual and reproductive health programs in U.S. and called for federal initiatives to support programs that help youth at high-risk (Manlove et al., 2015). Cigarette smoking is the leading cause of disease such as cancer, heart disease, stroke, lung disease, diabetes, chronic obstructive pulmonary disease (COPD) and early death in U.S. (CDC, 2020d; Sims & Committee on Substance, 2009), while heavy alcohol consumption in adolescents is associated with adult alcoholism and premature death (Marshall, 2014). The National CDC YRBS has provided valuable information regarding tobacco and alcohol use in adolescents. While the percentage of

adolescents that use tobacco has been falling consistently every time the survey has been implemented, the percentage of adolescents using electronic vaping products has increased from 3% to 3.3% in a two-year period (CDC, 2018). In terms of alcohol use, non-Hispanic Whites had the highest percentage of binge drinking (17.3%) when compared to Hispanic (12.4%) and African American (6.2%) (CDC, 2019c).

Nevertheless, populations that participate in local health surveillance are different compared to national surveyed populations. The factors that influence adolescent health and wellbeing are complex, therefore data obtained from local health surveys can differ from national representative data. For instance, New Mexico, with a high percentage of Hispanic population, developed the Youth Risk and Resiliency Survey (NM YRRS) based on the CDC's YRBSS. The NM YRRS has provided local stakeholders with valuable information on health risk behaviors that often differ from data from national reports (NM YRRS, 2017). Furthermore, The NM YRRS was modified to evaluate resilience, a health-related topic that is not included in the original National CDC YRBSS (Hall et al., 2018).

1.4. Theory and Framework for Adolescents Health-Risk Behaviors

Proposed relationships among natural phenomena of adolescents' health and health risk behaviors are not restricted to only one theoretical framework; therefore, to guide our research and evaluate how the specific concepts of traditional and emerging health risk behaviors and health-related outcomes are interrelated to one another among adolescents, we proposed to use Jessor & Jessor's problem-behavior theory (1977), and Jessor's conceptual framework for adolescent risk behavior (1991) (Jessor, 1991; Jessor & Jessor, 1977).

The problem-behavior theory by Richard and Shirley Jessor (1977) comprises concepts to understand youth development and explain different social behaviors among adolescents. The

framework was first constructed to explain heavy alcohol use in a rural community (Figure 1.3) and since then the model has been revised and expanded to address other behaviors across sociocultural settings.

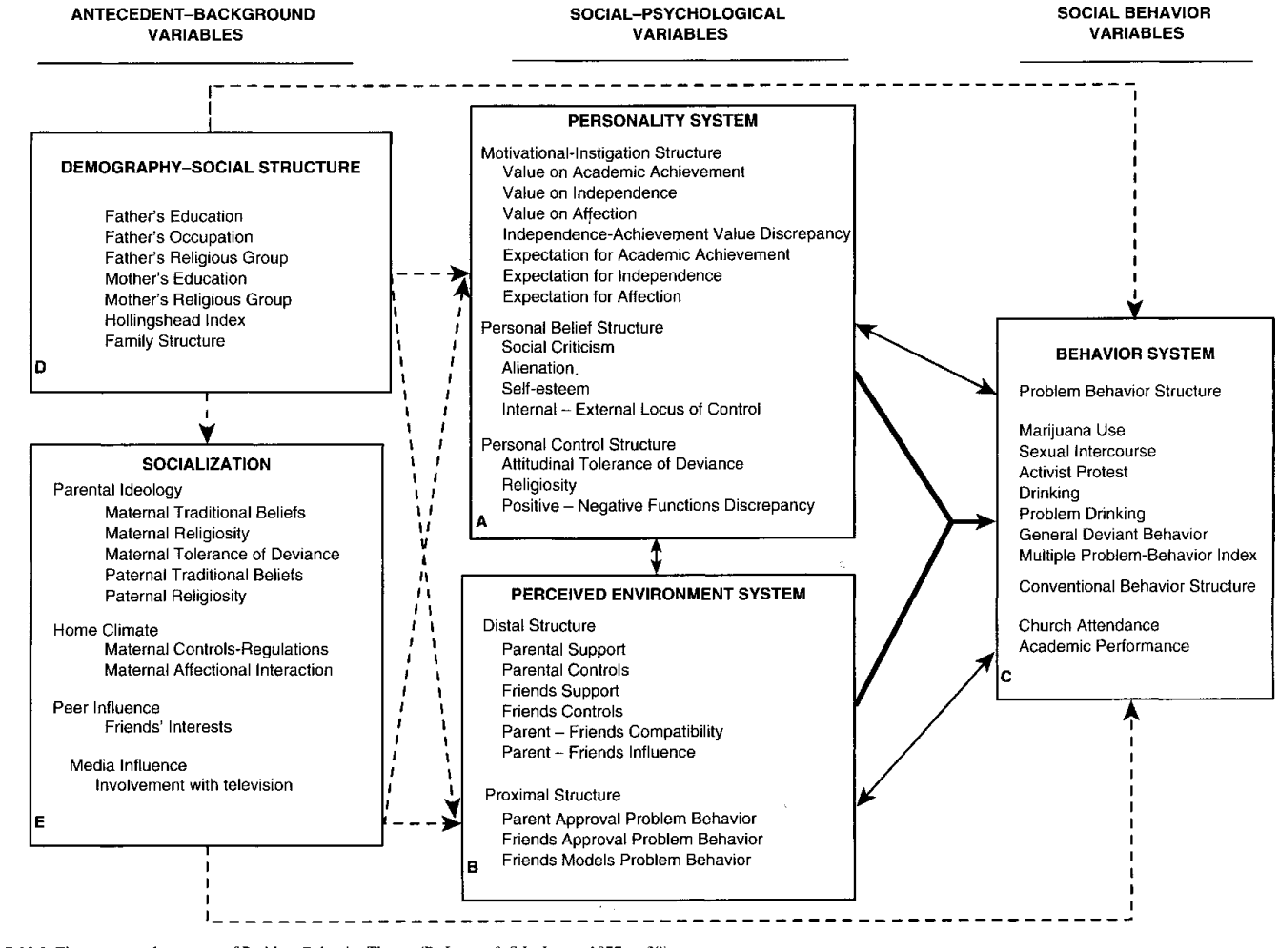

Figure 1.3. The conceptual structure of problem-behavior theory (Jessor & Jessor, 1977).

Based on Jessor's theory, to explain problem behavior during adolescence, we need to consider the adolescent's psychosocial and behavioral attributes, as well as the situation and the larger society in which such behavior takes place as behavior is the outcome of the interaction between personality and perceived environment. Jessor's problem-behavior theory has been useful to provide rationale of why adolescents engage in behaviors with health risk; and it is

grounded on the balance between instigations and constraints within three major systems (perceived-environment system, personality system, and behavior system).

Furthermore, the researcher goes beyond his previously mentioned work, and provided a new conceptual framework to explain adolescent risk behavior based on psychosocial factors and outcomes of problem behaviors (Jessor, 1991). The current conceptual framework for adolescent risk behavior extended the theory of problem behavior to include all those behaviors or risk factors that can have a negative impact on the health and successful development of adolescents (Figure 1.4). The revised framework includes 3 major components: risk and protective factors, adolescents' risk behaviors and lifestyles, and health and life-compromising outcomes. Jessor (1991) stated that "effects of different risk domains are intermediated through other risk domains" and called them a "web of causation" due to the multidirectional influences and interrelations within the risk and protection factors.

The conceptual framework has also been useful to cluster behavior identification. Jessor's extended problem-behavior theory (1991) and found that it supports the covariation among risk behaviors within an individual which can result in a phenomenon known as "risk behavior syndrome." Jessor's conceptual structure, within the behavior system, theorized that engagement in one problem-behavior increases the likelihood of engagement in other forms of problem-behavior. The clustering of health risk behaviors (e.g., poor diet, low levels of physical activity, tobacco use, etc.) may aggravate poor educational attainment, poor social and health outcomes during adolescence as well as shape an unhealthy lifestyle during adulthood.

The framework has been extended by other researchers to identify lifestyle profiles using adolescent data and providing evidence for problem-behavior as a syndrome, since modifiable lifestyle risk behaviors (mLRBs) often co-occur or tend to cluster in certain groups of

adolescents (DuRant et al., 1999; Meader et al., 2016; Nelson & Gordon-Larsen, 2006; Noble et al., 2015).

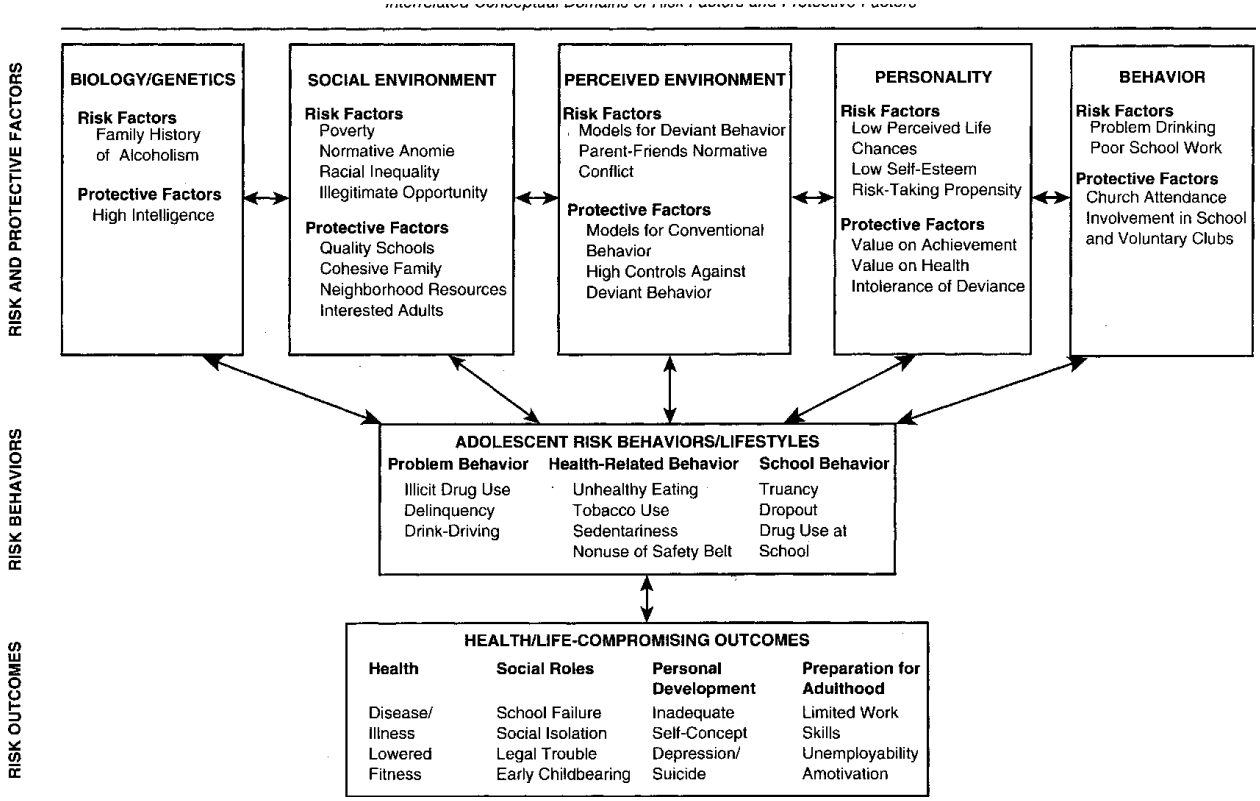

Figure 1.4. A conceptual framework for adolescent risk behavior (Jessor, 1991), p. 602).

Consequently, it has been concluded (Zweig et al., 2002) that students in the highest risk profile (i.e., with the highest number of risk behaviors) consistently reported lower levels of protective factors and higher levels of vulnerability factors. Likewise, students in the lowest risk profile had consistently higher levels of protective factors and lower levels of vulnerability factors when compared to students in any other profile. The framework suggests that instead of analyzing isolated risk behaviors, it is important to explore profiles to capture the multidimensional nature of adolescents' mLRBs. Moreover, risk factors for NCDs typically cluster or co-occur, and evidence suggest that grouping of mLRBs have a synergistic effect,

making certain combinations of mLRBs more harmful to health than the effect of an individual behavior (French et al., 2008; Poortinga, 2007).

CHAPTER 2: STATEMENT OF THE PROBLEM

Results from the CDC YRBSS represent a significant source of information for national, state, tribal, and local jurisdictions on the topic of health risk behaviors and public health (Brener et al., 2013; Underwood et al., 2020). The National YRBSS is not designed to produce representative estimates at the state level (Underwood et al., 2020) and the Texas YRBSS is also not designed to produce estimates at the County level, either for urban/rural areas or border/non-border regions, since the data sets do not include location identifiers (Texas_YRBS, 2019). The YRBSS has been implemented consistently only in selected large urban school districts that are federally funded across the state by the CDC; however, the CDC allows local entities to conduct their own survey as a measure of their youths' health risk behaviors.

El Paso County, Texas has a unique profile that differs from the representative national and state averages. El Paso County is a distinctive place due to the unusually large Hispanic/Latino population and its location near to the US-Mexico border. In 2020, El Paso County was the ninth-most populous county in the state of Texas with a population of 865 thousand. According to the 2020 U.S. Census Bureau, 82.9% of the El Paso County population is of Hispanic or Latino origin, a significant figure when compared to 19.1% and 40.2% of the average national and Texas, respectively (US_Census, 2020). Besides, the estimated population living below the poverty level was 20.1% in El Paso County; substantially higher than the U.S. and Texas averages of 11.5% and 14.0%%, respectively. Also, the percent of residents who spoke at home a language other than English was 69.3% (U.S. 21.76% and TX 35.1%), and the percent of foreign-born occupants was 23.6% (U.S. 13.6 % and TX 17.0%). In addition, the median household income reported in El Paso County was estimated to be $50, 919, as compared to $67,321 in Texas and $69,021 in the U.S. (US_Census, 2020).

These unique El Paso County demographics could represent multiple sources of potential disparities in health risk behaviors as compared to the state of Texas and the U.S. as a whole. Moreover, this region has a disproportionate burden of overweight, obesity, and its concomitant chronic diseases. For instance, El Paso County has an elevated adult overweight and obese prevalence (e.g., 68.2%) and deaths due to diabetes (e.g., 32.4 per 100,000 population) when compared to the national averages of 66.6% and 21.2% respectively (HPdelN, 2017).

With an interest in documenting the health-related behaviors of high school adolescents, The Paso del Norte Health Foundation (PDNHF), in collaboration with The University of Texas at El Paso (UTEP) and other stakeholders created a local version of the survey based on the CDC YRBSS. The initial local survey was implemented at the El Paso Independent School District (EPISD) in 2015, and an in 2019 an updated version was implemented at the Canutillo Independent School District CISD).

The availability of local and reliable data on modifiable lifestyle risk behaviors (mLRBs) for NCDs is critical for communities such as El Paso County, Texas. Research has shown that health risk behaviors can co-occur within populations, and engaging in only one risk behavior increases the risk of engaging in additional ones. Therefore, we believe that a comprehensive analysis of the local 2019 YRBS data could yield valuable information for our community.

Herein we propose a secondary data analysis of certain variables from the 2019 EP-YRBS survey (original/parent study) related to health risk behaviors for NCDs. The proposed secondary data analysis aims to examine the occurrence and co-occurrence of traditional (physical inactivity, unhealthy dietary behaviors, smoking, and alcohol use) and emerging (sedentary behavior and unhealthy sleep periods) mLRBs. Furthermore, to the best of our knowledge, no studies have yet examined the association between weight status and a

combination of traditional and emerging mLRBs among Hispanic/Latino American adolescents living in a low-income community in the US-Mexico border region.

The proposed secondary data analysis is in accordance with a target set forth by Healthy People, specifically with the goal of "improving the health and well-being of adolescents" by the year 2030. Table 2.1 shows the alignments between key Healthy People 2030 objectives focused at enhancing adolescent health and the aspects addressed in this study. This secondary data analysis explored specific available variables including body mass index (BMI), depression symptom, school performance, physical activity, six dietary behaviors, alcohol consumption, tobacco use, recreational sedentary behavior (screen time), and sleep time.

To the best of our knowledge, the CDC has not conducted the national standardized YRBSS survey in El Paso County. Near to our region, data on health risk behaviors have primarily been collected from large school districts (i.e., Fort Worth, TX and Houston, TX) or at the state level (i.e., Texas). The existing CDC information on health risk behaviors among Hispanic/Latino adolescents in Texas relies on extrapolations based on the ethnic composition of the general population, which does not account for the unique sociodemographic profile of El Paso County. In addition, it appears that there may be limited research focusing on the combined engagement with traditional and emerging mLRBs among Hispanic/Latino Americans adolescents. The overarching goal of this study is to identify specific mLRBs patterns of multiple health risk behaviors that could guide and inform the development of culturally appropriate lifestyle interventions aimed at preventing NCDs premature morbidity and mortality among the local Hispanic population.

Table 2.1. This table shows the alignment of this study with a specific Healthy People 2030 goal and several objectives directed toward the well-being of adolescents.

Adolescents Health – Healthy People 2030	
Goal: Improve the health and well-being of adolescents.	
Objectives:	*Overweight and Obesity:* — Reduce the proportion of children and adolescents with obesity — NWS-04 *Physical Activity:* — Increase the proportion of adolescents who do enough aerobic physical activity — PA-06* — Increase the proportion of parents who follow AAP recommendations on limiting screen time for children aged 6 to 17 years — PA-R02 *Sleep:* — Increase the proportion of high school students who get enough sleep — SH-04* *Nutrition and Healthy Eating:* — Increase fruit consumption by people aged 2 years and over — NWS-06 — Increase vegetable consumption by people aged 2 years and older — NWS-07 — Reduce consumption of added sugars by people aged 2 years and over — NWS-10 *Tobacco Use:* — Reduce current tobacco use in adolescents — TU-04 — Reduce current e-cigarette use in adolescents — TU-05 — Reduce current cigarette smoking in adolescents — TU-06 *Alcohol Use:* — Reduce the proportion of adolescents who drank alcohol in the past month — SU-04 *Mental Health and Mental Disorders:* — Reduce suicide attempts by adolescents — MHMD-02 *Schools:* — Increase the proportion of adolescents who participate in daily school physical education — ECBP-01

* Objective status reported as getting worse

2.1. Research Questions, Hypotheses, and Specific Aims

The relationships among modifiable lifestyle risk behaviors (mLRBs) for NCDs are complex, and these mLRBs often tend to co-occur or cluster together within populations, magnifying their adverse health effects beyond their individual impacts. The initiation of

engagement with mLRBs typically occurs during adolescence, influencing health outcomes in their teenage years, in their adulthood, as well as in subsequent generations.

The overarching goal of this study revolves around identifying specific mLRBs and patterns to inform the design of future culturally targeted lifestyle interventions that promote the adoption of healthier behaviors, which in turn, could significantly reduce the incidence and impact of NCDs within our local community. The purpose of this secondary data analysis is to examine mLRBs associated with NCDs among a local sample of Hispanic/Latino American adolescents living in the US-Mexio border region of El Paso County, Texas. The research questions, their corresponding hypotheses, and the specific aims of the study are as follows:

Research Question 1: What is the prevalence of traditional and emerging mLRBs among local adolescents, and how do these vary by sex, school grade, and body weight status?

Hypothesis 1: The prevalence of traditional and emerging mLRBs for NCDs (as listed below) will exhibit statistically significant differences within the local sample when stratified by sex, school grade, and body weight status.

Hypothesis 1.1: When stratified by sex, and based on the extrapolated 2019 National CDC YRBSS results for Hispanic/Latino, it is hypothesized that females will exhibit higher prevalence of insufficient PA, non-attendance to PE classes, skipping breakfast, not drinking enough milk, OH consumption, increased RSST, overweight, short ST and felt sadness or hopeless, while males will exhibit higher prevalence of TOB use, low fruit and vegetable intake, soda consumption, and obesity.

Hypothesis 1.2: When stratified by school grade and based on the extrapolated 2019 National CDC YRBSS results for Hispanic/Latino, it is hypothesized that 9th graders will

exhibit higher prevalence of low vegetable intake, soda consumption, obesity, while 10th graders will exhibit a higher prevalence of insufficient PA, non-attendance to PE classes, low fruit intake, not drinking enough milk, skipping breakfast, TOB use, OH consumption; increased RSST, short ST, overweight, and felt sadness or hopeless.

Hypothesis 1.3: When stratified by body weight status, it is hypothesized that students with a BMI-for-age equal to or greater than the 85th percentile (overweight and obese) will exhibit a higher prevalence of traditional and emerging mLRBs, including insufficient PA, non-attendance to PE classes, low fruit and vegetable intake, not drinking enough milk, soda consumption, skipping breakfast, TOB use, OH consumption, increased RSST, short ST, as well as felt sadness or hopeless.

Specific Aim 1: To determine the overall point prevalence of both traditional mLRBs, including insufficient physical activity (PA), non-attendance to PE classes, poor dietary behaviors (DIET), tobacco use (TOB), and alcohol consumption (OH), as well as emerging mLRBs, including increased recreational sedentary screen time (RSST) and short sleep time (ST). For a comprehensive examination, the local sample was stratified by sex, grade level, and body weight status, and cross-sectional intermediate health outcomes such as overweight, obese, symptom of depression, and school performance were also considered.

Research Question 2: Are there any differences between the local sample finding and the national and state averages reported by the CDC YRBSS in the same year 2019 regarding traditional and emerging mLRBs and cross-sectional health-related outcomes?

Hypothesis 2: The prevalence estimates of traditional and emerging mLRBs, as well as health-related outcomes measured in 2019 among the local sample of adolescents, stratified by

grade, will significantly differ from the prevalence estimates reported by the CDC YRBSS National and Texas levels for the same year.

Hypothesis 2.1: The prevalences of mLRBs among local 9th graders are expected to be significantly different than the peer prevalences at the national and state levels.

Hypothesis 2.2: The prevalences of mLRBs among local 10th graders are expected to be significantly different than the peer prevalences at the national and state levels.

Specific Aim 2: To compare to the 2019 CDC YRBSS national and state reported average the local sample finding and determine whether there are differences in traditional and emerging mLRBs, including insufficient PA, non-attendance to PE classes, no fruit and vegetable intake, not drinking milk, soda consumption, skipping breakfast, TOB use, OH consumption, increased RSST, short ST, as well as cross-sectional intermediate health outcomes such as overweight, obese, and symptom of depression.

Research Question 3: To what extent do local adolescents adhere to the 24-hour movement behaviors (24-h MBs) concept, meeting all three recommended guidelines for physical activity (PA), recreational sedentary screen time (RSST), and sleep Time (ST) simultaneously?

Hypothesis 3: A significant difference will exist between the proportion of local adolescents meeting 24-hr MBs concept, achieving all three guidelines simultaneously, as compared to the overall estimate reported of 4.0% (95% CI: 3.5-4.4), and when stratified by sex, when compared to the prevalence estimates reported for females (2.5%, 95% CI: 2.0-3.0) and males (5.4%, 95% CI: 4.7-6.1) from a representative national sample of Hispanic/Latino high school-aged students by Knell et al., 2019.

Specific Aim 3: To evaluate the adherence to the 24-h MBs concept in our local sample of adolescents, specifically assessing the compliance to the recommended guidelines for physical activity (PA), recreational sedentary screen time (RSST), and sleep time (ST), simultaneously, and compare findings to the estimates reported from a representative national sample of Hispanic/Latino high school-aged adolescents by Knell et al., 2019.

Research Question 4: What are the different lifestyles combinations or unique groups among the local sample of adolescents when focusing on the 4 traditional and the 2 emerging mLRBs?

Hypothesis 4: Distinct clusters will exist among the local sample of adolescents based on co-occurrence of the mLRBs.

Specific Aim 4: To assess whether there are different lifestyle combinations or unique exclusive clusters among the local sample of adolescents based on the four traditional mLRBs, including insufficient PA, unhealthy dietary habits (DIET), tobacco (TOB) use, alcohol (OH) consumption, as well as the two emerging mLRBs for NCDs, including increased recreational sedentary screen time (RSST), short sleep time(ST). Analysis will be performed using both the original dataset (complete cases) and a newly imputed dataset generated with a multiple imputation technique in SPSS. Additionally, if stable clusters are found, to observe potential cluster differences regarding cross-sectional intermediate health-related outcomes such as overweight, obese, symptom of depression, and school performance.

Research Question 5: Does incorporating of the two emerging mLRBs (RSST and ST) alongside the four traditional mLRBs into a lifestyle health risk index for adolescents predicts cross-sectional intermediate health-related outcomes?

Hypothesis 5: An adolescent lifestyle health risk index that includes the two emergent mLRBs alongside the four traditional mLRBs, in total 6 mLRBs will be expected to significantly predict cross-sectional health-related outcomes such as body weight status, symptom of depression, and school performance.

Specific Aim 5: To explore the significance of incorporating two emerging mLRBs (RSST and ST) alongside the four traditional mLRBs into a health risk index within our local sample adapted from (Ding et al., 2015) & (Mewton et al., 2019). A multiple logistic regression modeling approach will be employed to assess an adolescent health risk index predictive capacity for cross-sectional health-related outcomes, including body weight status, symptom of depression, and school performance. This involved building a basic traditional model and comparing it with three emergent models, each incorporating either RRST, ST, or both behaviors. The respective risk index scores were calculated based on the sum of mLRBs engaged by adolescents, with behaviors coded as 1 = At Risk and 0 = Not at Risk. Additionally, identify the most common pattern combinations of traditional and emergent mLRBs occurring in the local sample.

CHAPTER 3: METHODS

NCDs represent a major public health concern, particularly prevalent in the adult population. Nevertheless, adolescence is a critical period during which health risk behaviors for most NCDs often take root and persist into adulthood. This study aims to identify traditional and emerging mLRBs related to NCDs, compare local findings with national and state averages, assess the 24-hr movement behaviors concept, investigate potential combinations or clusters of these mLRBs, and explore their significance as a health risk index within a local sample of Hispanic/Latino adolescents residing in El Paso County, TX, along the US-Mexico border region in 2019. This chapter outlines the study's design, data source, measurements, data preparation, study sample, and data analysis.

3.1. Study Design

The study design for this research project involves a secondary data analysis that relies on existing data from a 2019 original/parent study titled "School-Based Surveillance System: El Paso Youth Health Behavior Survey," hereafter referred to as the 2019 El Paso YHBS. The cross-sectional original/parent survey was conducted in two public high schools within an Independent School District from a low-income community from El Paso County during the 2019-2020 academic year, before the onset of the 2019 COVID pandemic.

3.2. Dataset Source

The data source for this secondary data analysis project is the 2019 El Paso YHBS, a collaborative effort between the Paso del Norte Institute for Healthy Living (IHL), The University of Texas at El Paso (UTEP), and the Canutillo Independent School District (CISD), sponsored by the Paso Del Norte Health Foundation. The 2019 El Paso YHBS project conducted an online survey to collect data on health-related behaviors among 9th and 10th graders in the

school district, with 751 student respondents. The main objective of the 2019 El Paso YHBS project was to inform school administrators and stakeholders about a range of health-related behaviors within the participating school population, with the ultimate goal of creating evidence-based health education programs and, in the long-term, establishing a youth surveillance system modeled after the CDC YRBSS.

3.2.1. Online Survey in the 2019 El Paso YHBS

The original/parent cross-sectional project, with approval from the UTEP IRB Committee and the CISD Research Review Board (UTEP-ID:1370785-2), emulated the CDC YRBSS and employed a validated survey in the 2019 El Paso YHBS. The CDC YRBSS National survey questions have demonstrated good reliability when administered in a paper version (Brener et al., 2002; Brener et al., 2003) and similar results were seen when using the online version/web-based method (Raghupathy & Hahn-Smith, 2012).

The 2019 El Paso YRBS was an online survey using a self-reported approach, where all the questions, except three items (i.e., race, height, and weight), were multiple-choice options with a minimum of 2 and a maximum of 8 exclusive response options and only one possible answer per question. This survey used to collect data from adolescent students at participating high schools was available in English and Spanish. All participants completed a one-time online questionnaire using QuestionPro® survey software, either at school computer labs or classrooms with school-provided laptops. Research assistants and trained school staff overseed the survey process to ensure privacy and emphasize voluntary and anonymous participation of the students.

The online survey comprised 80 health-related questions and was administered on two regular school days in different classrooms during 45-minute class periods in November 2019. Importantly, the survey was designed to contain no identifiable individual information, and

participants had the freedom to skip questions or stop the survey at any time. The online survey covered various health-related aspects of students' everyday lives, including nutrition, physical activity, substance use, sexual behavior, dating violence, and factors impacting their well-being, such as school, home, and community relationships.

3.2.2. Demographic Characteristics of the Study Population

Canutillo, Texas, a census-designated place in El Paso County, is part of the El Paso metropolitan statistical area and encompasses the zip codes 79835 and 79932 (Figure 3.1). In 2020, it had a population of 6,212, with a predominantly Hispanic or Latino demographic (94.4%). A significant portion of its population was foreign-born (25.4% from 2017-2021), and a considerable portion were under 18 years old (36.1%).

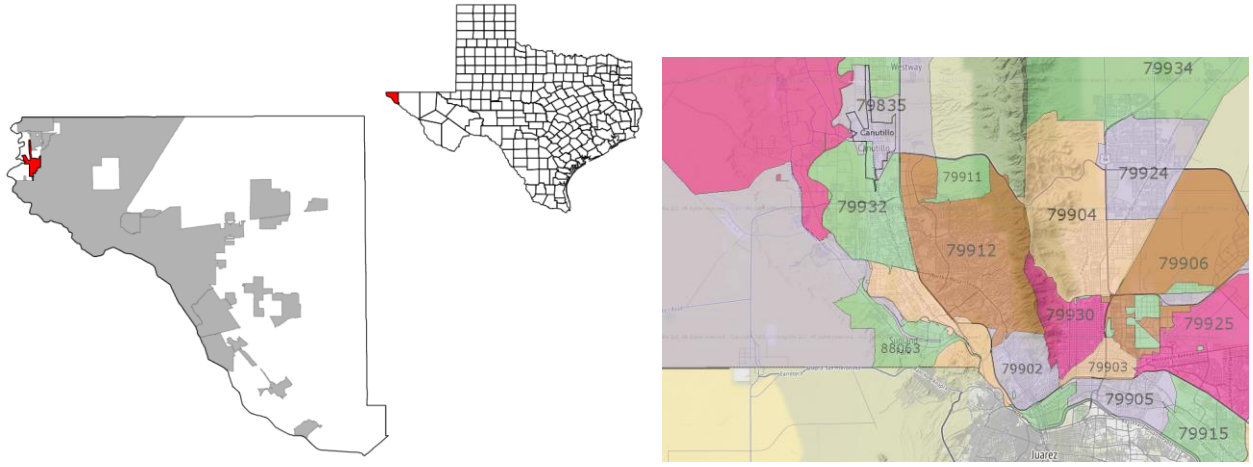

Figure 3.1. Location of Canutillo CDP in El Paso County, Texas (Academic, 2000a, 2000b; Zipmap, 2019).

According to the U.S. Census Bureau (2017-2021), the median household income in Canutillo was $35,685, with 32.7% living in poverty, and 26.3% lacking health insurance. The area covers 2.75 square miles, with a population density of 2,262.2 people per square mile in

2020. It's considered an urban area within a metropolitan setting based on various population and housing statistics (Ratcliffe et al., 2016; US_Census, 2020).

3.3. Data Preparation

The 2019 El Paso YHBS data was collected electronically using the secure QuestionPro® survey software and without any identifiers linked to the identity of participants or school classes. There were two datasets from the original/parent project, each from the participation high schools, and were imported into SPSS software. Both datasets were integrated (concatenated) to create a single dataset that showed a total of 824 online entries of students who clicked the link provided to access the online survey.

Following the guidelines outlined in the 2019 CDC YRBS Data User's Guide, all questionnaires underwent evaluation, and all the recommended procedures were applied to our dataset and carried out as specified below (CDC, 2020a). Initially, a total of 812 students actively consented to participate in the original/parent project out of the 824 registered entries to the online link. The first 12 cases were excluded, with 6 participants responding "No" to the consent form and another 6 failing to provide an answer in this variable that registered the online assent consent. Additionally, 12 more cases were eliminated because all survey questions were left unanswered, resulting in an initial pool of 800 surveys.

All items in the online survey were multiple-choice options, allowing for only one possible answer per question, except for those assessing race, height, and weight. The initial step involved editing data on height and weight variables, scrutinizing responses for logical consistency, correct range, and biological plausibility. These variables, which required participants to self-input their height and weight numbers, underwent a thoroughly reviewed and cleaned. Unacceptable or unfitting inputs were identified and removed in these columns. For

instance, invalid answers such as, “yes”, “???”, “joe”, “idk” “no lo se”, “I don't know but I'm mid weight but heavy”, etc., were set as NAs.

Additionally, in order to validate the height and weight input-values from the original local dataset, the guidelines outlined in the 2019 YRBS Data User’s Guide were carefully followed (CDC, 2020a). These recommendations specify that if values were initially provided in the Imperial system, they should be converted to international units using the provided formulas:

$$\text{Height (m)} = [(\text{feet} \times 12) + \text{inches}] \times 0.0254 \text{ m/in}$$

$$\text{Weight (kg)} = \text{Weight (lbs)} \times 0.4536 \text{ kg/lb}$$

If either height or weight entries were missing or values were unreadable, they were designated as missing values (NAs). In cases where height or weight was missing, the BMI was also set to missing. Conversely, if height and weight were both available values, the BMI was calculated for each participant using the provided formula:

$$\text{BMI} = \text{kg/m}^2 = \text{Weight (kg)} / [\text{Height (m)}^2]$$

Moreover, the 2019 YRBS Data User’s Guide imposes an additional control to validate the values self-input on the 3 aforementioned variables. Participants must provide valid entries for the age, sex, height (HT) and weight (WT) variables in order to ensure the biological plausibility on the newly calculated BMI variable. If the variables of age or sex were missing, HT, WT, and BMI were set to missing since the biologically implausible limits are constructed based on the age and sex of the adolescents, as illustrated in Table 3.1.

After completing the basic edits for HT, WT, and BMI, additional controls were implemented to ensure all values were biologically plausible. Using the CDC percentile calculator for children and teens (https://www.cdc.gov/healthyweight/bmi/calculator.html) and employing the metric system, the BMI-for-age categories and percentiles for each participant

were manually calculated. In addition, each of the entries were scrutinized, and if any observation for HT, WT, and the calculated BMI values fell outside the control range of limit values (Table 3) established by the CDC Division of Nutrition, Physical Activity and Obesity, they were marked as "Implausible." Subsequently, 180 cases were eliminated, and 620 cases were left for consideration for further analysis in this study.

Table 3.1. 2019 YRBS Data User's Guide table for biologically plausible measures that shows the range limit values established by the CDC Division of Nutrition, Physical Activity and Obesity (CDC, 2020a).

Age	Males	Females
≤ 12	Weight: 11.657983 -146.733304 kg Height: 1.1519311-1.84082588 m BMI: 11.386213-56.226598	Weight: 11.900826-155.212672 kg Height: 1.18383072-1.82903476 m BMI: 10.684393-60.443302
13	Weight: 13.01124-158.329381 kg Height: 1.19831085-1.92017136 m BMI: 11.67613-57.898109	Weight: 14.501968-168.600125 kg Height: 1.25570614-1.85942807 m BMI: 10.997169-63.347099
14	Weight: 15.57739-168.290461 kg Height: 1.25554043-1.97881762 m BMI: 12.031145-58.918535	Weight: 17.710244-179.291483 kg Height: 1.28862593-1.87503851 m BMI: 11.380272-65.988852
15	Weight: 19.111809-177.825263 kg Height: 1.31651031-2.01195659 m BMI: 12.428272-59.453976	Weight: 20.91703-187.432302 kg Height: 1.30017723 -1.88288604 m BMI: 11.801096-68.493982
16	Weight: 22.781044-187.460307 kg Height: 1.36300909-2.02979265 m BMI: 12.841111-59.756767	Weight: 23.425077-193.22019 kg Height: 1.30445494-1.88692675 m BMI: 12.216444-71.040599
17	Weight: 25.553403-195.782942 kg Height: 1.38993951-2.04023389 m BMI: 13.24194-60.165336	Weight: 24.75328-196.530029 kg Height: 1.30637781-1.88910363 m BMI: 12.572284-73.856658
≥ 18	Weight: 27.014802-200.070426 kg Height: 1.40280564-2.04670061 m BMI: 13.60222-61.101798	Weight: 24.848651-197.222141 kg Height: 1.30741589-1.89033105 m BMI: 12.804466-77.216716

After completing the controls for biologically implausible values, the 2019 YRBS Data User's Guide requires consistency edits for the multiple-choice questions to maintain the

integrity of the standard high school questionnaire. This process involves comparing two questions at a time to ensure logical consistency in their answers and preserve internal coherence. If the responses to two questions are logically conflicted, both answers in the pair of questions are marked as missing, with the exception of comparisons involving demographic questions, where the demographic answer is maintained. The 2019 YRBS Data User's Guide outlines 149 specific pairs of questions comparisons criteria, and all consistency comparisons applicable to the available variables in the local dataset were executed.

Continuing with the 2019 YRBS Data User's Guide procedures, and after the logical consistency edits, the questionnaires were explored for potential record subversion. This next established recommendation involved identifying and eliminating surveys deemed too incomplete to be valid for analysis. In this step, questionnaires were marked as "subverted" when either had 20 or fewer answers or displayed a repetitive pattern of 15 or more answers with 'b,' 'c,' 'd,' 'e,' 'f,' 'g,' or 'h.' This step resulted in 16 cases with repetitive 'a' answer pattern that did not meet the criterion, and 3 cases marked as subverted due to having fewer than 20 responses and excluded from the dataset.

After completing all quality control procedures on the local dataset (n=824), 617 valid questionnaires remained. Subsequently, following the 2019 YRBS Data User's Guide, the next step involved generating or computing new variables as detailed in appendixes A, B, and C. The comprehensive guide and its appendixes provide detailed instructions on how to create the variables for race/ethnicity, overweight and obese percentile (i.e., raceeth, QNOWT, and QNOBESE), as well as guidance on converting the multiple-choice variables into two types of dichotomous variables (i.e., QN# and QNword). Approximately 70 new variables were

generated. For specific details and instructions on variable creation and computation, please refer to the available guide in here 2019 YRBS Data User's Guide.

Furthermore, a new data set was prepared specifically for this research project, containing only surveys previously validated and variables of interest. Appendix A showcased the questionnaire items used in this secondary data analysis derived from the original/parental 2019 El Paso YHBS study. The table in the appendix outlines the original answer options available in the local survey and presents the local survey items' compatibility with the 2019 CDC National survey. Also, based on the 2019 CDC recommendations and guidelines, the responses of interest (ROIs) that align with the purpose of this study were highlighted as bold letters within the table in order to illustrate the answer options selected for dichotomizing and preparing the new variables for the secondary data analysis (Appendix A).

3.4. Study Sample

Approximately 800 students voluntarily participated in the original/parent 2019 El Paso YHBS study. Subsequently, for the purpose of this research project, a cohort of 617 potential participants was identified through a rigorous examination based on adherence to the procedures outlined in 2019 YRBS Data User's Guide (detailed in the previous section). Furthermore, the inclusion criteria for this secondary data analysis project comprised adolescents self-identifying as Hispanic or Latino, aged 17 or younger, and enrolled in either 9th or 10th grade classrooms. Exclusion criteria included an age of 18 or older (3 cases), not providing school grade or being enrolled in 11th or 12th grade (1, 26 and 5 cases, respectively), lacking identification or not self-identifying as Hispanic or Latino (8 cases and 35 cases, respectively). After ensuring the online surveys met stringent data quality control measures and eliminating a total of 78 participants

based on the specific inclusion or exclusion criteria, a final study sample of 539 adolescents was established for further analysis.

3.4.1. Institutional Review Board (IRB)

An IRB application [1749096-2] titled "Behavioral Risk Factors for Non-Communicable Diseases Among Hispanic American Adolescents Living in El Paso County" was submitted to the University of Texas at El Paso IRB committee and qualified for exemption from full review under federal guidelines. The proposed research project is based on secondary data analyses derived from the 2019 El Paso YHBS, an original cross-sectional study approved by the UTEP IRB Board [1370785-2] and the CISD Research Review Board. The proposed project aligns with the exempt human subject research category specified in the Code of Federal Regulations, where consent is not required due to the utilization of existing data handled to maintain participant anonymity, as outlined in the 45 CFR 46.104(d)(4)(ii).

3.4.2. Missing Data Management

Since missing values (NAs) are common in data collection, the created dataset for this project underwent analysis to evaluate and address NAs, and a second dataset without the NAs was created based on accepted statistical conventions. The approach to missing data in this study was a multiple imputation technique (SPSS Statistics/IBM) which is one of the most common and acceptable ways to replace missing data in health surveys (Ghosh & Pahwa, 2008; Tsiampalis & Panagiotakos, 2020). Since TSC and logistic regression models are classified as probabilistic-based methods and cannot accommodate missing data (omit cases with any missing values), the multiple imputation technique in SPSS was employed to estimate the missing values to retain the largest number of cases possible in the analytical sample, reduce bias in the

parameter estimates, and misleading results in the final analyses surveys (Ghosh & Pahwa, 2008; Tsiampalis & Panagiotakos, 2020).

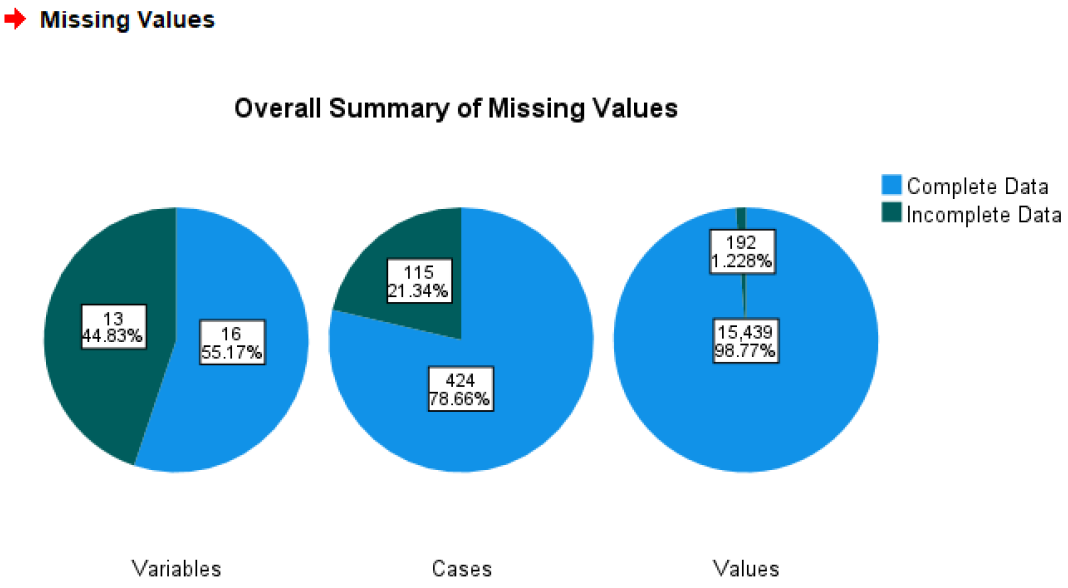

Figure 3.2. Overall summary of missing values before multiple imputation techniques among our local sample (n=539).

All variables relevant to the analysis in these last two sections of the study underwent the missing value analysis, any variable with at least 0.1% of NAs was reported. The overall summary showed that there was little missing data (Figure 3.2): among the 29 variables included, 13 (44.83%) displayed one or more missing values; among the 539 cases, 115 (21.34%) had one or more missing values; and a total of 1.228% (192) individual data values were found to be missing.

Missing data is classified into three categories: missing completely at random (MCAR), missing at random (MAR), and missing not at random (MNAR). Data is considered MCAR when all observations have the same probability of being missing. Data is deemed MAR when

observations being missing have the same probability only within groups defined by observed data. Data MNAR means that the probability of observations being missing varies due to unobserved reasons.

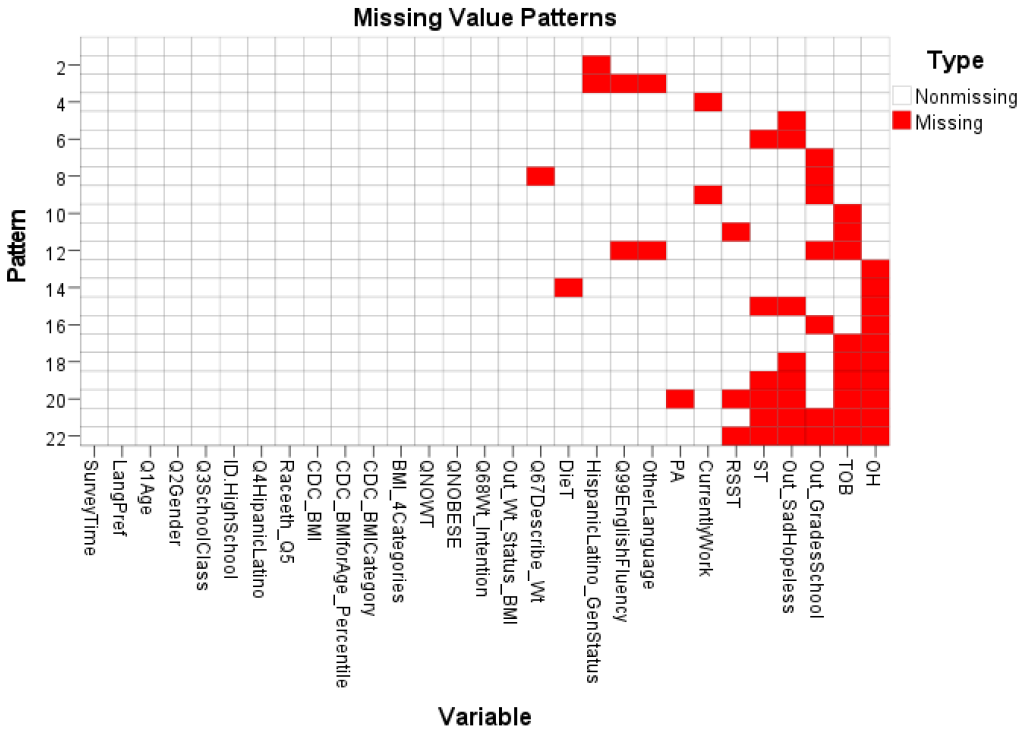

Figure 3.3. Missing values patterns before multiple imputation techniques among our local sample (n=539).

After running a missing value analysis and according to the univariate statistics, the NAs distribution is as follows: 10.4% (n=56) for OH, 8.0% (43) for TOB, 5.9% (32) school grade binomial, 4.3% (23) for sad/hopeless,3.7% (20) for ST, and a minimum missingness of 0.7% (4) for variables RSST and job, 0.4% (2) for PA, generation status, speak other language, and English fluidity, and 0.2% (1) for DIET, and weight description variables. The tabulated patterns of group of cases with same incomplete and complete data shows a missing value at random (MAR) pattern, which means that some of the missing values could be explained by other

variables such as age, high school, current work, and weight related variables and a monotone pattern is observed in the missing data (Figure 3.3).

Based on Rubin's work, it is assumed that the number of imputations could be set at 5 (Rubin, 1976). Then, Graham recommended that at least 20 imputed datasets are needed when testing relationships between variables to constrain the loss of power (Graham et al., 2007), and Bodner proposed guidelines based on the fraction of missing information (FMI) to determine the number of imputations (Bodner, 2008).

Afterward, White, Royston, and Wood (2011) proposed a rule of thumb based on Bodner's FMI work and states that the number of imputed datasets should be at least equal to the percentage of missing cases (White et al., 2011). Additionally, according to Van Buuren (2018), the number of iterations should depend on the missing data percentage and the correlation between variables, but he proposes to have adequate convergence this number can be set between 5-20 (Van Buuren, 2018). In this study, the default number of 10 iterations was used and since approximately 20% of the subjects had missing values, then at least 20 imputed data sets were generated.

3.5. Study Measurements

The risk behaviors were defined based on the CDC recommendations for adolescents, and all measurement included in this study are detailed below. Student who self-reported engagement in any risk behavior were recoded as '1 = 'yes.' Appendix A contains the selected variables from the original/parental 2019 El Paso YRBS study, detailing the wordiness of each question and its exact corresponding response options before dichotomizations.

Traditional mLRBs:

Insufficient Physical Activity (PA): Defined as students who did not engage in physical activity for a total of at least 60 minutes per day within the 7 days prior of the survey, considering summing up all instances during the day where students increased their heart and respiratory rate.

Not attending physical education (PE) classes: Defined as students who did not participate in PE classes on all 5 days during an average school week.

Unhealthy dietary behaviors (DIET): As a concept was assessed by combining the five-food related behaviors available in the local survey, and it was defined as not meeting at least 3 out of five dietary CDC recommendations, specifically for not fruit or vegetables intake, not drinking enough milk, soda consumption, and skipping breakfast.

Low fruit intake: Defined as students who did not consume fruit at least once or more times per day during the 7 days before the survey. *Not eating fruit* was determined when there was an absence of any fruit consumption within the same week period.

Low vegetables intake: Defined as students who did not consume vegetables at least once or more times per day during the 7 days before the survey. *Not eating vegetables* was determined when there was an absence of any vegetable consumption within the same week period.

Not drinking enough milk: Define as students who did not consume at least 3 glasses of milk per day during the 7 days prior the survey, including any milk consumed in a glass or cup, from a carton, with cereal or half pint (one glass) of milk served at school.

Soda consumption: Define as students who did drink a can, bottle, or glass of soda or pop such as Coke, Pepsi, or Sprite, excluding diet soda or diet pop, within the 7 days prior the survey.

Skipping breakfast: Define as students who did not consume any breakfast during the 7 days preceding the survey.

Tobacco (TOB) use: Defined in participants who reported using or smoking even one or two puffs of any tobacco products such as cigarettes, electronic vapor product, smoke tobacco or flavored tobacco in a hookah, on a at least 1 day within the 30 days preceding the survey.

Alcohol (OH) consumption: Defined as participants who reported consuming at least one drink of alcohol on at least 1 day within the 30 days preceding the survey.

Emergent mLRBs:

Increased recreational sedentary screen time (RSST): Defined as participants engaging in activities such as watching videos, play videogames, texting, or using social media on electronic devices, not related to schoolwork, including smartphones, computers, gaming consoles (e.g., Xbox, PlayStation), iPads, or other tablets, on an average school day.

Short sleep time (ST): Defined as participants reported having 7 or less hours of sleep time on an average school night.

Cross-sectional Outcomes:

Body Weight Status: Determined using CDC BMI-for-age, overweight classification was deemed equal to or above the 85th percentile to below the 95th percentile, while obesity was above the 95th percentile. Together, overweight and obesity classification were regarded as excess body weight status.

Symptom for depression: Identified when participants reported experiencing persistent feelings of sadness or hopelessness almost every day for two weeks or more in a row within the past 12 months before the survey, resulting in reduction or cessation of some of their usual activities.

Low School performance: Define as participants self-described their grades in school as mostly C's, D's, or F's during the past 12 months before the survey.

3.6. Data Analysis

The purpose of this secondary data analysis is to examine mLRBs associated with NCDs among a local sample of Hispanic/Latino American adolescents living in the US-Mexio border region of El Paso County, Texas. The primary objectives of this project were 1) to determine the prevalence of both traditional mLRBs, such as insufficient physical activity (PA), poor dietary behaviors (DIET), tobacco use (TOB), and alcohol consumption (OH), as well as emerging mLRBs including increased recreational sedentary screen time (RSST) and short sleep time (ST) and asses available cross-sectional intermediate health outcomes including body weight status, symptom of depression, and school performance; 2) to compare the local findings to the national and state averages; 3) to assess the concept of 24-hour movement behaviors; 4) to investigate potential combinations or clusters of these traditional and emerging mLRBs; and 5) to explore whether the inclusion of the two emerging mLRBs (RSST and ST) alongside the four traditional mLRBs provides relevant information regarding a health risk index for adolescents and predicts cross-sectional intermediate health outcomes, as well as identify the most commonly lifestyle patterns among our local sample.

All data was collected using the Question Pro® software and was analyzed with SPSS® software for Windows version 28 or similar (SPSS Inc., Chicago, IL, USA). The proposed project was analyzed through univariate, bivariate, multivariate, and clustering analyses, using the appropriate statistical tests based on the type of variables. Descriptive statistics were provided for the sample using the available demographic variables such as age, sex, employment, speak English and another language, as well as generational status. Furthermore, descriptive

analyses were performed for all nominal and ordinal categorical variables proportions and confidence intervals were calculated, as well as a few continuous variables were examined with mean, standard deviation (SD). Binomial confidence intervals (95% CI) were calculated, and p-values < 0.05 were considered statistically significant. A summary of the scoring method for mLRBs, based on the CDC recommendations for adolescents, is presented in Table 3.2; detailed scoring methods for all variables and each specific dietary behavior are described in the measures section above.

Table 3.2. Summary of scoring method for modifiable lifestyle risk behaviors (mLRBs) based on the CDC recommendations for adolescents.

	Modifiable Lifestyle Risk Behaviors Scoring Method: 1 = At Risk, 0 = Not at Risk.
Traditional mLRBs	
PA (Physical Activity)	**1** = have not engaged in at least 60 minutes per day on physical activity during the past 7 days prior to the survey
Diet (Dietary Behavior)	**1** = have not meet at least 3 out of the 5 food-related items as recommended by the CDC within the prior week (including fruit, vegetables, soda, milk, and breakfast)
TOB (Tobacco Use)	**1** = have use any tobacco product at least on one day during the 30 days prior to the survey (including cigarettes, electronic vapor products, or smoked or flavored tobacco in hookah)
OH (Alcohol Consumption)	**1** = consuming alcohol beverages at least a glass of alcohol during the past 30 days prior to the survey
Emerging mLRBs	
RSST (Recreational Sedentary Screen Time)	**1** = have spent 3 or more hours a day on recreational sedentary screen time on an average school day (including TVs, computers, videogames, smartphones, iPads, or tablets)
ST (Sleep Time)	**1** = have sleep for less than 8 hours on an average school night

3.6.1. Individual mLRBs Analysis:

The overall point prevalence of each individual mLRB was reported, as well as by sex, school grade, and body weight status, including prevalence of both traditional mLRBs, such as

insufficient physical activity (PA), attendance to PE classes, poor dietary behaviors (DIET) concept, as well the five-food items (i.e., fruits, vegetables, milk, soda, breakfast), any tobacco (TOB) use, and alcohol (OH) consumption, as well as prevalence of emerging mLRBs, including increased recreational sedentary screen time (RSST) and short sleep time (ST), and prevalence of cross-sectional intermediate health/outcomes, including body weight status, symptom of depression, and school performance. Accordingly, sample comparisons stratified by sex, school grade, and body weight status categories to look for differences in proportions were performed using Pearson chi-square test and p-values <0.05 were considered significant.

To compare the local findings with the national and state averages reported on the same year (2019), specific data was extracted from the CDC's YRBSS interactive tables available on their website https://nccd.cdc.gov/Youthonline/App/Default.aspx. The extracted proportions from the national and state levels were aligned and stratified to match the characteristics of the local sample, which comprised Hispanic/Latino students in the 9th and 10th grades in order to be able to compare to corresponding peers. For this comparative analysis, one-sided binomial tests were conducted for each compatible mLRB and cross-sectional outcome in each different grade and level group, and results with p-values <0.05 were considered statistically significant difference from US or Texas, respectively.

3.6.2. Combined mLRBs Analysis:

To evaluate this trendy concept of the 24-hour movement behaviors (24-h MBs) in our local sample we used physical activity, recreational sedentary screen time, and slept time behaviors. First, the prevalence and 95% CIs of meeting each behavior individually, as well as combinations of meting 0, 1, 2, or all the 3 movement behaviors guidelines were estimated overall and stratified by sample characteristic, including sex, school grade, and body weight

status. The prevalence of meeting each 24-h MBs guideline and in different pair combinations were also estimated, and Vento diagrams were constructed. Also, the overall and stratified by sex local findings were compared using one-sample binomial test to the fixed values reported by Knell et.al., 2019 from a nationally representative sample of U.S. Hispanic/Latino high school-aged students obtained from 4 previous cycles (i.e., 2011, 2013, 2015, 2017) of the CDC YRBSS. The national overall value was reported as of 4.0% (95% CI 3.5, 4.4), and when stratified by sex, national females value was 2.5% (95% CI 2.0, 3.0) and males was 5.4% (95% CI 4.7, 6.1); p-values <0.05 were considered statistically significant. In addition, logistic regression modeling was used to assess the association between meeting the 24-h MBs concept and body weight status controlling for age and school grade.

The Two-Step Cluster analysis was employed to explore the possible co-occurrence of risk behaviors and identify unique homogeneous groups among our local sample by including the four traditional mLRBs [insufficient physical activity (PA), unhealthy dietary behaviors (Diet), tobacco use (TOB), alcohol consumption (OH)] and the two emerging mLRBs [increased recreational sedentary screen time (RSST), and reduced sleep time (ST)]. The quality of the formed clusters was assessed using several metrics, including the Silhouette coefficient, the ratio of the sizes of the largest and smallest clusters, and variable importance.

The Silhouette coefficient is a commonly used metric to evaluate the effectiveness of clustering techniques, ranging from -1 to 1. A value close to -1 indicates that the clusters are incorrectly assigned, a value around 0 suggests indifference or insignificant distance between clusters, and a value close to 1 indicates well-separated and clearly differentiated clusters. In terms of classification, a coefficient between -1 and 0.2 is considered 'Poor', between 0.2 and 0.5 as 'Fair', and between 0.5 and 1 as 'Good' quality clusters."

In a TSC analysis, the ratio of sizes between the largest and smallest clusters is used as a measure of cluster size imbalance. This ratio indicates how evenly or unevenly the cases are distributed across the clusters. A common guideline is to aim for a ratio of less than 3:1, as a higher ratio suggests a greater imbalance in cluster sizes. Therefore, it is preferred to have a lower ratio to obtain a more balanced and informative clustering solution.

The interpretation of the TSC predictor variable importance is based on the log-likelihood ratio (LLR) statistic, which compares the fit of the clustering model with and without each variable. A larger LLR value indicates that the variable significantly improves the fit of the clustering model, suggesting its importance in differentiating the clusters. On the other hand, a small LLR value indicates that the variable does not significantly contribute to the clustering solution. TSC analysis will be performed in both the original dataset and in a newly imputed dataset to assess cluster stability and replicability; if cluster remain stables the distribution of the cross-sectional outcomes such as body weight status, symptom of depression, and school performance will be explored, and Pearson Chi-square test were used to look for proportion's differences; p-values <0.05 were considered statistically significant.

3.6.3. Exploring an Adolescent Lifestyle Risk Index and Patterns:

Identified the most frequently occurring combinations of mLRBs among a local sample of Hispanic/Latino American adolescents living along the U.S.-Mexico border region based on the imputed dataset. All possible mutually exclusive combinations based on the 6 mLRBs were created, and the percentage of students in each possible lifestyle pattern were calculated for the local sample. In addition, to explore whether a practical adolescent lifestyle risk index had an impact on the classification of cross-sectional outcomes within our local sample of Hispanic/Latino adolescents using the selected multiple imputed dataset (MI #6). Based on the

imputed dataset and using a multiple logistic regression modeling approach, determined if the inclusion of the two emerging mLRBs (RSST and ST) alongside the four traditional mLRBs provides relevant information regarding cross-sectional intermediate outcomes prediction.

Based on the used imputed data (n=539), brief descriptive on each traditional and emerging mLRBs were provided. The basic traditional mLRBs index (range 0-4) will be used as the basic model, including [PA + Diet +TOB +OH], and the inclusion of the two emerging mLRBs (RSST and ST) resulted in three additional models Traditional + RSST, Traditional + ST, and Traditional + RSST +ST. Using the regression logistic regression models examine whether the inclusion of the two emerging mLRBs differed from the basic model on the score and impact on classification of cross-sectional outcomes including body weight status, symptom of depression, and school performance, while controlling sex, and school grade.

CHAPTER 4: RESULTS

This section presents the results of a secondary data analysis aimed at assessing modifiable lifestyle risk behaviors (mLRBs) associated with NCDs among a local sample of high school Hispanic/Latino adolescents residing in the U.S.-Mexico border region within El Paso County, TX. The secondary data analysis utilized data collected in the original/parental 2019 El Paso YHBS study, a cross-sectional survey which was modeled after the CDC Youth Risk Behavior Surveillance System (YRBSS), long-term ongoing research effort.

The primary objectives of this project were to determine the prevalence of both traditional mLRBs, such as insufficient physical activity (PA), poor dietary behaviors (DIET), tobacco use (TOB), and alcohol consumption (OH), as well as emerging mLRBs, including increased recreational sedentary screen time (RSST) and short sleep time (ST), and asses cross-sectional intermediate health outcomes, including body weight status, symptom of depression, and school performance. Stratification by sex, school grade, and body weight status allowed for the identification of notable differences in behavior prevalence, particularly among female adolescents and 10th grade students.

Additionally, a comparison of the local findings to the 2019 CDC YRBSS state and national averages data highlighted variations in mLRB prevalence among local students. Furthermore, assessing the concept of 24-hour movement behaviors (24-MBs) provided a broader perspective on compliance with three important health-related behaviors (physical activity, recreational sedentary screen time, and sleep time). Cluster analysis was used to detect potential combinations or co-occurrence of these traditional and emerging mLRBs and distinct groups with varying levels of at-risk behaviors among the participants were detected. Finally, this study also explored whether the inclusion of the two emerging mLRBs (RSST and ST)

alongside the four traditional mLRBs provided relevant information using a health risk index adapted for adolescents and predicts cross-sectional intermediate health outcomes, as well as identify the most commonly lifestyle patterns among a local sample of Hispanic/Latino adolescents.

4.1. Characteristics of Participants

This secondary data analysis included a total of 539 Hispanic/Latino in-school adolescent residing within El Paso County, Texas. The participants were attending two different high schools within the same school district. Approximately 25% of participants were from a vocational/trade school and 75% were from a traditional school, 44% were in enrolled in 9th grade while 56% were in 10th grade (Figure 4.1).

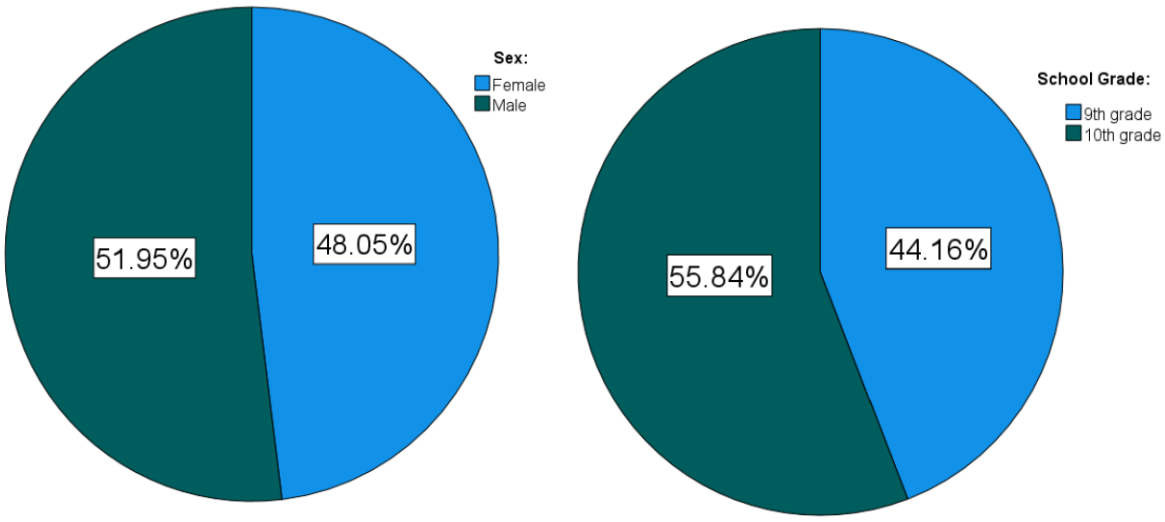

Figure 4.1. Characteristics of study participants by sex and school grade.

Participants were eligible to inclusion in the study if they provided responses to four key questions (i.e., age, sex, height, and weight). These variables were necessary to validate their biological plausibility of BMI-for-age. Additional criteria for eligibility included being 17 years of age or younger and identify themselves as Hispanic/Latino. Participants who reported an age

of 18 years or older were excluded from the study. Furthermore, participants' data was considered invalid and excluded from this study if more than 80% of their responses were missing in the original survey. Out of the 824 initial online click registrations on ProQuest for the original/parental study, 626 questionnaires met the criteria to validate biological plausibility. After applying inclusion and exclusion criteria, 78 questionnaires were excluded, and 9 more were eliminated due to quality control issues. As a result, 539 usable questionnaires (65.4%) remained for this secondary data analysis.

Table 4.1. Demographic Characteristics of Study Participants (n=539).

Variable	Description	9th (n=238) No. (%)	10th (n=301) No. (%)	Total (n=539) No. (%)
Age				
	13yo	2 (0.8)	---	2 (0.4)
	14yo	159 (66.8)	5 (1.7)	164 (30.4)
	15yo	74 (31.1)	202 (67.1)	276 (51.2)
	16yo	3 (1.3)	91 (30.2)	94 (17.4)
	17yo	---	3 (1.0)	3 (0.6)
Sex				
	Females	111 (46.6)	148 (49.2)	259 (48.1)
	Males	127 (53.4)	153 (50.8)	280 (51.9)
Currently Work				
	Yes	16 (6.8)	30 (10.0)	46 (8.6)
	No	220 (93.2)	269 (90.0)	489 (91.4)
Speak English				
	Very Well	172 (72.9)	214 (71.1)	386 (71.9)
	Well	53 (22.5)	73 (24.3)	126 (23.5)
	Not Well	10 (4.2)	12 (4.0)	22 (4.1)
	Not at All	1 (0.4)	2 (0.7)	3 (0.6)
At home speak a language other than English				
	Never	36 (15.3)	32 (10.6)	68 (12.7)
	Less than half the time	51 (21.6)	76 (25.2)	127 (23.6)
	About half the time	64 (27.1)	68 (22.6)	132 (24.6)
	More than half the time	32 (13.6)	60 (19.9)	92 (17.1)
	All of the time	53 (22.5)	65 (21.6)	118 (22.0)
Generational Status				
	1st Gen or Higher	9 (3.8)	17 (5.7)	26 (4.8)
	2nd Gen or Higher	134 (56.5)	178 (59.3)	312 (58.1)
	3rd Gen or Higher	54 (22.8)	79 (26.3)	133 (24.8)
	4th Gen or Higher	40 (16.9)	26 (8.7)	66 (12.3)

As shown in Figure 4.1, almost half of the adolescent participants were female (48%). The sample ages ranged from 13 to 17 years, with the following distribution: 15 years (51%), 14 years (30%), 16 years (17%), and a combined 1% for 13 and 17 years. A large majority of participants reported not to be working (91%), having good or very good English language proficiency (95%), and 64% indicated that they speak a language other than English at home about half of the time or more, as shown in Table 4.1,

Regarding the generational status of participants' Hispanic/Latino identity, 5% were self-identified as 1st generation, indicating that they were born outside the U.S (REFERENCE https://immigrationinitiative.harvard.edu) More than half of the participants (58%) were identified as 2nd generation, meaning that they were born in U.S. Additionally, 25% of participants were identified as 3rd generation, and 12% as 4th generation or higher, signifying that they were U.S.-born children with U.S.-born parents or grandparents, respectively. Table 4.1 exhibits all available demographic characteristics of local Hispanic/Latino participants.

4.2. Aim 1: Prevalence of mLRBs and Cross-Sectional Outcomes Among a Local Sample of Hispanic/Latino Adolescents: Stratified Analysis by Sex, Grade, and Body Weight Status

Specific Aim 1 sought to determine the point prevalence of individual traditional and emerging mLRBs in reference to CDC recommendations among a local sample of Hispanic/Latino high school students living in a U.S.-Mexico border region (n=539). The results are presented for the entire sample and are also stratified by sex, school grade, and body weight status.

In reference to traditional mLRBs findings indicate that 69.6% (95% CI 65.6 – 73.5) of participants did not engage in at least 60 minutes of physical activity per day on all 7 days; 51.0% (95% CI 46.7 – 55.3) did not attend physical education classes on all five days of an

average school week. About individual dietary behaviors, 62.3% (95% CI 58.0 – 66.4) did not consume fruit at least once a day; 68.0% (95% CI 63.9 – 72.0) did not consume vegetables at least once a day; 66.9% (95% CI 62.7 – 70.8) consumed at least one sugar-sweetened soda in the past seven days; 90.9% (95% CI 88.1 – 93.2) did not consume at least three glasses of milk per day in the past seven days; and 60.3% (95% CI 56.0 – 64.4) did not eat breakfast on all seven days of the week prior to implementing the survey. Regarding substance use, 23.4% (95% CI 19.7 – 27.4) of participants reported current use of tobacco products in the past 30 days, while 17.4% (95% CI 14.1 – 21.1) reported consuming alcohol in the past 30 days prior to the survey.

In reference to the emerging mLRBs, 62.6% (95% CI 58.4 – 66.7) of participants reported engaging in three or more hours of recreational sedentary screen time (i.e., use of television, computer, or videogames for non-school purposes) on an average school day, while 64.2% (95% CI 59.9 – 68.3) reported having seven or fewer hours of sleep on an average school night.

In terms of health-related intermediate outcomes, 33.5% (95% CI 29.4 – 37.6) of adolescents had non-normal body weight status, defined according to the CDC as having a calculated BMIs-for-age either below the 5^{th} percentile or equal to or greater than the 85^{th} percentile. Additionally, 40.5% (95% CI 36.2 – 44.9) of students reported experiencing a symptom of depression (feeling sad or hopeless almost every day for 2 weeks or more in a row that the participant stopped doing some usual activities) during the past year previous to answering the survey; and 20.9% (95% CI 17.4 – 24.7) had had a low school performance, indicated by obtaining mostly C's, D's or F's grades, in the past 12 months.

Table 4.2. Percentages of local Hispanic/Latino adolescents who **did not meet** CDC recommendations for mLRB and outcomes, stratified by sex.

CDC's Recommendations:	***Total*** *% (95 CI) (n=539)*	***Females*** *% (95 CI) (n=259)*	***Males*** *% (95 CI) (n=280)*
Traditional Risk Behaviors			
Physical Activity Behaviors:			
Students had not been physically active for a total of ≥60 minutes/day on all 7 days	69.6 (65.6 – 73.5)	79.8 (74.4 – 84.6)	60.2* (54.2 – 66.0)
Students did not attend physical education classes on all 5 days in an average school week	51.0 (46.7 – 55.3)	57.8 (51.5 – 63.9)	44.8* (38.9 – 50.8)
Dietary Behaviors:			
Students had not eaten fruit at least 1 time/day during the past 7 days	62.3 (58.0 – 66.4)	59.1 (52.8 – 65.1)	65.2 (59.3 – 70.8)
Students had not eaten veggies at least 1 time/day during the past 7 days	68.0 (63.9 – 72.0)	70.0 (64.0 – 75.6)	66.2 (60.3 – 71.7)
Students drank at least 1 sugar-sweetened soda during the past 7 days	66.9 (62.7 – 70.8)	59.7 (53.4 – 65.7)	73.5* (67.9 – 78.6)
Students did not drink at least 3 glasses of milk/day during the past 7 days	90.9 (88.1 – 93.2)	93.8 (90.1 – 96.4)	88.2* (83.8 – 91.7)
Students did not eat breakfast on all 7 days of the week prior to the survey	60.3 (56.0 – 64.4)	70.0 (64.0 – 75.6)	51.3* (45.2 – 57.3)
Other Health Behaviors:			
Students were currently using tobacco products during the past 30 days	23.4 (19.7 – 27.4)	21.4 (16.4 – 27.2)	25.2 (20.0 – 31.0)
Students were currently drinking alcohol during the past 30 days	17.4 (14.1 – 21.1)	19.0 (14.1 – 24.6)	15.9 (11.6 – 21.1)
Emerging Risk Behaviors			
Sedentary Behavior:			
Students had 3 or more hours of recreational screen time on an average school day (television, computer, or videogames)	62.6 (58.4 – 66.7)	62.5 (56.3 – 68.5)	62.7 (56.8 – 68.4)
Sleep Behavior:			
Students had 7 or fewer hours of sleep time on an average school night	64.2 (59.9 – 68.3)	69.2 (63.1 – 74.9)	59.6* (53.5 – 65.4)
Cross-Sectional Outcomes			
Weight Status:			
Students with BMIs within ≥85th and <95th percentile (Overweight)	15.6 (12.6 – 18.9)	17.8 (13.3 – 23.0)	13.6 (9.8 – 18.1)
Students with BMIs ≥95th percentile (Obese Category)	16.0 (13.0 – 19.3)	12.7 (8.9 – 17.4)	18.9 (14.5 – 24.0)
Depression Symptom:			
Students that were sad or hopeless almost every day for 2 weeks or more in the past year	40.5 (36.2 – 44.9)	56.5 (50.1 – 62.8)	25.9* (20.8 – 31.6)
School Performance:			
Students with low school performance (mostly Cs or lower grades) during the past 12 months	20.9 (17.4 – 24.7)	13.5 (9.5 – 18.4)	27.9 (22.5 – 33.7)

*Significantly different than female students based on Pearson chi-square test ($p<0.05$)
Conditions: Binary x Binary (2x2) & No cells with expected count than 5. **Statistical Analysis:** Pearson chi-square test.

Overall, considering the traditional and emerging mLRBs as individual variables, a significant proportion of participants reported engaging in behaviors associated with increased health risks. Table 4.2 summarizes the previously mentioned overall findings among the studied population as well as the mLRBs and cross-sectional intermediate health outcomes examined for a more in deep understanding of the differences between males and females.

4.2.1. Sex-Stratified Analysis.

When stratifying the original data by sex, it was found that out of the 15 individually measured variables, female adolescents exhibited a higher prevalence on 7 mLRBs and 2 outcomes, when compared to their male counterparts (Table 4.2). Specifically, a significantly higher percentage of female students (79.8%) compared to male students (60.2%) reported not being physically active for at least 60 minutes per day on all 7 days (X^2 (1, N = 537) = 24.43, p < 0.001). Additionally, a significantly higher proportion of female students (57.8%) compared to male students (44.8%) reported not attending physical education classes on all 5 days in an average school week (X^2 (1, N = 537) = 8.99, p = 0.003).

When comparing unhealthy dietary habits, although not statistically significant (NS), female participants exhibited a higher prevalence of not eating vegetables at least once a day during the past 7 days compared to males (70.0% vs 66.2%; NS). Additionally, a significantly higher percentage of female participants (93.8%) compared to males (88.2%) reported not consuming at least 3 glasses of milk per day during the past 7 days (X^2 (1, N = 537) = 5.11, p = 0.024). Similarly, a significantly higher proportion of female participants (70.0%) compared to males (51.3%) reported not eating breakfast on all 7 days of the week prior to the survey (X^2 (1, N = 537) = 19.71, p < 0.001).

Additionally, although not statistically significant, a higher percentage of female adolescents reported drinking alcohol during the past 30 days (females 19.0% vs males 15.9%; NS), and a significantly higher percentage of females (69.2%) compared to males (59.6%) reported having 7 or fewer hours of sleep on an average school night (X^2 (1, N = 519) = 5.27, p = 0.022). In terms of health-related intermediate outcomes, although not statistically significant, a higher percentage of female students than male students had CDC's BMIs-for-age within $\geq 85^{th}$ and $<95^{th}$ percentile and were categorized as overweight (females 17.8 % vs males 13.6%; NS). Following the same trend, a significantly higher percentage of female students (56.5%) compared to male students (25.9%) exhibited feeling sad or hopeless almost every day for at least 2 weeks in a row or more in the past year (X^2 (1, N = 516) = 49.94, p <0.001).

Among the 15 individual measured items, male adolescents showed a higher prevalence in 4 mLRBs and 2 outcomes variables compared to their female counterparts (Table 4.2). A higher percentage of male students than female students reported not eating fruit at least once a day during the past 7 days (65.2% vs 59.1%; NS). Moreover, a significantly higher proportion of males (73.5%) compared to females (59.7%) reported consuming at least one sugar-sweetened soda in the past 7 days (X^2 (1, N = 537) = 11.49, p <.001). Additionally, a higher proportion of male students reported using tobacco products during the past 30 days (25.2% vs 21.4%; NS). A similar proportion of males and females (62.7% vs 62.5%; NS) reported engaging in three or more hours of recreational sedentary screen time (i.e., use of television, computer, or videogames for non-school purposes) on an average school day.

Table 4.3. Percentages of local Hispanic/Latino adolescents who **did not meet** CDC recommendations for mLRB and outcomes, stratified by school grade.

CDC's Recommendations:	***Total*** *% (95 CI) (n=539)*	***9th Grade*** *% (95 CI) (n=238)*	***10th Grade*** *% (95 CI) (n=301)*
Traditional Risk Behaviors			
Physical Activity Behaviors:			
Students had not been physically active for a total of ≥60 minutes/day on all 7 days	69.6 (65.6 – 73.5)	66.7 (60.3 – 72.6)	72.0 (66.6 – 77.0)
Students did not attend physical education classes on all 5 days in an average school week	51.0 (46.7 – 55.3)	41.8 (35.4 – 48.3)	58.3* (52.5 – 64.0)
Dietary Behaviors:			
Students had not eaten fruit at least 1 time/day during the past 7 days	62.3 (58.0 – 66.4)	63.0 (56.6 – 69.2)	61.7 (55.9 – 67.2)
Students had not eaten veggies at least 1 time/day during the past 7 days	68.0 (63.9 – 72.0)	71.2 (65.0 – 76.9)	65.6 (59.9 – 70.9)
Students drank at least 1 sugar-sweetened soda during the past 7 days	66.9 (62.7 – 70.8)	68.1 (61.7 – 73.9)	65.9 (60.2 – 71.2)
Students did not drink at least 3 glasses of milk/day during the past 7 days	90.9 (88.1 – 93.2)	89.5 (84.9 – 93.1)	92.0 (88.3 – 94.8)
Students did not eat breakfast on all 7 days of the week prior to the survey	60.3 (56.0 – 64.4)	54.6 (48.1 – 61.1)	64.8* (59.0 – 70.2)
Other Health Behaviors:			
Students were currently using tobacco products during the past 30 days	23.4 (19.7 – 27.4)	20.8 (15.6 – 26.9)	25.4 (20.4 – 30.9)
Students were currently drinking alcohol during the past 30 days	17.4 (14.1 – 21.1)	13.0 (8.7 – 18.3)	20.7* (16.1 – 26.0)
Emerging Risk Behaviors			
Sedentary Behavior:			
Students had 3 or more hours of recreational screen time on an average school day (television, computer, or videogames)	62.6 (58.4 – 66.7)	63.6 (57.1 – 69.7)	61.9 (56.1 – 67.4)
Sleep Behavior:			
Students had 7 or fewer hours of sleep time on an average school night	64.2 (59.9 – 68.3)	64.8 (58.2 – 71.0)	63.7 (57.9 – 69.2)
Cross-Sectional Outcomes			
Weight Status:			
Students with BMIs within ≥85th and <95th percentile (Overweight)	15.6 (12.6 – 18.9)	17.6 (13.0 – 23.1)	14.0 (10.2 – 18.4)
Students with BMIs ≥95th percentile (Obese Category)	16.0 (13.0 – 19.3)	16.4 (11.9 – 21.7)	15.6 (11.7 – 20.2)
Depression Symptom:			
Students that were sad or hopeless almost every day for 2 weeks or more in the past year	40.5 (36.2 – 44.9)	37.3 (31.0 – 44.0)	43.0 (37.2 – 48.9)
School Performance:			
Students with low school performance (mostly Cs or lower grades) during the past 12 months	20.9 (17.4 – 24.7)	17.4 (12.6 – 23.1)	23.5 (18.8 – 28.9)

*Significantly different than 9th grade students based on Pearson chi-square test ($p<0.05$)
Conditions: Binary x Binary (2x2) & No cells with expected count less than 5. **Analysis:** Pearson chi-square test

Regarding cross-sectional intermediate health outcomes, a higher percentage of male adolescents (18.9%) compared to female adolescents (12.7%) had BMI-for-age equal to or greater than 95th percentile, indicating obesity with a marginally significant difference, X^2 (1, N = 539) = 3.84, p = 0.050). Also, although not statistically significant, more males than females exhibited a higher prevalence of lower school performance, as indicated by obtaining mostly Cs or lower grades during the past 12 months (27.9% vs 13.5%; NS).

4.2.2. School Grade-Stratified Analysis

To gain a better understanding of the differences between adolescents in 9th and 10th grade in the local sample, the original data was stratified by school grade. Findings from the individual mLRBs, and cross-sectional intermediate health outcomes examined in this analysis are displayed in Table 4.3. When the data was stratified by grade, it was found that 9th grade students exhibited a higher prevalence in 5 mLRBs and 2 outcomes out of the 15 individually measured variables when compared to their 10th grade counterparts. Although not statistically significant, a higher percentage of 9th graders than 10th graders had not eaten fruit at least once a day during the past 7 days (63.0% vs 61.7%; NS), had not eaten vegetables at least once a day during the past 7 days (71.2% vs 65.6%; NS), and had drunk at least 1 sugar-sweetened soda during the past 7 days (68.1% vs 65.9%; NS). In addition, a higher percentage of 9th grade students than 10th grade students had engaged in 3 or more hours of recreational sedentary screen time (i.e., use of television, computer, or videogames for non-school purposes) on an average school day (63.6% vs 61.9%; NS) and had 7 or fewer hours of sleep on an average school night (63.6% vs 61.9%; NS).

Regarding cross-sectional intermediate health outcomes (Table 4.3), although not statistically significant, a higher percentage of 9th graders compared to 10th graders had CDC's

BMI-for-age within the range of ≥85th and <95th percentile, categorizing these participants as being overweight (17.6 % vs 14.0%; NS). Additionally, more 9th graders than 10th graders had BMI-for-age equal to or greater than 95th percentile, categorizing these participants as being obese (16.4% vs 15.6%; NS).

Among the 15 individual variables that were measured (Table 4.3), 10th-grade students exhibited a higher prevalence in 6 mLRBs and 2 outcomes variables when compared to their peers in 9th grade. A significantly higher proportion of 10th graders (58.3%) compared to 9th graders (41.8%) reported not attending physical education classes on all 5 days of an average school week (X^2 (1, N = 537) = 14.53, p < 0.001). Although not statistically significant, it is noteworthy that a higher percentage of 10th grade students compared to 9th grade students had not engaged in at least 60 minutes of physical activity per day on all 7 days (72.0% vs 66.7%; NS). Similarly, a higher proportion of 10th graders reported not consuming at least 3 glasses of milk per day during the past 7 days (92.0% vs 89.5%; NS) and a significantly higher proportion of 10th graders (64.8%) compared to 9th graders (54.6%) reported not eating breakfast on all 7 days of the week prior to the survey (X^2 (1, N = 536) = 5.68, p = 0.017). Furthermore, a higher percentage of 10th graders (20.7%) compared to 9th graders (13.0%) reported currently drinking alcohol during the past 30 days (X^2 (1, N = 483) = 4.95, p = 0.026). A similar but not statistically significant trend was observed when 10th graders reported a higher use of tobacco products during the past 30 days (25.4% vs 20.8%; NS).

Regarding cross-sectional intermediate health outcomes (Table 4.3), specifically feeling sad or hopeless almost every day for at least 2 weeks in a row or more in the past year, the prevalence between 9th and 10th graders was not statistically significant. However, it is notable that a higher proportion of 10th graders (43.0% vs 37.3%; NS) than 9th graders reported feeling

this way. Also, not statistically significant, more 10th graders reported lower school performance, indicated by mostly C's or lower grades during the past 12 months (23.5% vs 17.4%; NS) than 9th graders students.

4.2.3. Body Weight Status-Stratified Analysis

Table 4.4 presents the prevalence of mLRBs and cross-sectional outcomes among the local sample of Hispanic/Latino high school students stratified by body weight status. Excess body weight (overweight or obese) is determined with a BMI-for-age equal to or greater than the ≥85th percentile based on the CDC's criteria.

Although not statistically significant, it is noteworthy that students categorized as either overweight or obese exhibited a higher prevalence of 8 mLRBs and 2 outcomes (e.g., depression symptom and school performance) out of the 13 individually measured variables compared to students without excess body weight.

Students identified as either overweight or obese exhibited a higher percentage of not being physically active for at least 60 minutes per day on all 7 days (73.5% vs 67.8%; NS), not attending physical education classes on all 5 days in an average school week (54.1% vs 49.6%; NS), and not eating fruit at least once a day during the past 7 days (62.9% vs 62.0%; NS) compared to adolescent students with no excess weight (Table 4.4).

Additionally, students identified as either overweight or obese, compared to students with no excess body weight, reported a higher percentage of not drinking at least 3 glasses of milk per day during the past 7 days (92.9% vs 89.9%; NS) and not eating breakfast on all 7 days prior to the survey (62.7% vs 59.1%; NS). Moreover, students classified with excess body weight were more likely to be currently using tobacco products during the past 30 days compared to students without excess body weight (24.8% vs 22.7%; NS).

Table 4.4. Percentages of local Hispanic/Latino adolescents who **did not meet** CDC recommendations for mLRB and outcomes, stratified by body weight status.

CDC's Recommendations:	***Total*** *% (95 CI) (n=539)*	***Excess Weight*** *% (95 CI) (n=170)*	***No Excess*** *% (95 CI) (n=369)*
Traditional Risk Behaviors			
Physical Activity Behaviors:			
Students had not been physically active for a total of ≥60 minutes/day on all 7 days	69.6 (65.6 – 73.5)	73.5 (66.2 – 80.0)	67.8 (62.8 – 72.6)
Students did not attend physical education classes on all 5 days in an average school week	51.0 (46.7 – 55.3)	54.1 (46.3 – 61.8)	49.6 (44.4 – 54.8)
Dietary Behaviors:			
Students had not eaten fruit at least 1 time/day during the past 7 days	62.3 (58.0 – 66.4)	62.9 (55.2 – 70.2)	62.0 (56.8 – 66.9)
Students had not eaten veggies at least 1 time/day during the past 7 days	68.0 (63.9 – 72.0)	66.9 (59.2 – 73.9)	68.6 (63.6 – 73.3)
Students drank at least 1 sugar-sweetened soda during the past 7 days	66.9 (62.7 – 70.8)	60.0 (52.2 – 67.4)	70.0* (65.1 – 74.7)
Students did not drink at least 3 glasses of milk/day during the past 7 days	90.9 (88.1 – 93.2)	92.9 (88.0 – 96.3)	89.9 (86.4 – 92.8)
Students did not eat breakfast on all 7 days of the week prior to the survey	60.3 (56.0 – 64.4)	62.7 (55.0 – 70.0)	59.1 (53.9 – 64.2)
Other Health Behaviors:			
Students were currently using tobacco products during the past 30 days	23.4 (19.7 – 27.4)	24.8 (18.2 – 32.5)	22.7 (18.4 – 27.5)
Students were currently drinking alcohol during the past 30 days	17.4 (14.1 – 21.1)	14.0 (8.9 – 20.6)	18.9 (14.9 – 23.5)
Emerging Risk Behaviors			
Sedentary Behavior:			
Students had 3 or more hours of recreational screen time on an average school day (television, computer, or videogames)	62.6 (58.4 – 66.7)	63.5 (55.8 – 70.8)	62.2 (57.0 – 67.2)
Sleep Behavior:			
Students had 7 or fewer hours of sleep time on an average school night	64.2 (59.9 – 68.3)	69.8 (62.1 – 76.7)	61.6 (56.4 – 66.7)
Cross-Sectional Outcomes			
Depression Symptom:			
Students that were sad or hopeless almost every day for 2 weeks or more in the past year	40.5 (36.2 – 44.9)	43.8 (36.1 – 51.8)	39.0 (33.9 – 44.3)
School Performance:			
Students with low school performance (mostly Cs or lower grades) during the past 12 months	20.9 (17.4 – 24.7)	24.7 (18.3 – 32.1)	19.1 (15.1 – 23.7)

*Significantly different than overweight/obese students based on Pearson chi-square test ($p<0.05$)
Conditions: Binary x Binary (2x2) & No cells with expected count less than 5. **Analysis:** Pearson chi-square test

Furthermore, a higher percentage of students identified with excess body weight (i.e., overweight or obese) than students without excess body weight reported engaging in 3 or more hours of recreational sedentary screen time (i.e., use of television, computer, or videogames for non-school purposes) on an average school day (63.5% vs 62.2%; NS) and having 7 or fewer hours of sleep time on an average school night (69.3% vs 61.6%; NS).

Regarding intermediate outcomes (Table 4.4), students identified as either overweight or obese had a higher percentage of reporting feeling sad or hopeless almost every day for at least 2 weeks in a row or more in the past year (43.8% vs 39.0%; NS) and reporting lower school performance with mostly Cs or lower grades during the past 12 months (24.7% vs 19.1%; NS) compared to students with no excess weight.

Lastly, it was observed that students identified with no excess body weight showed a higher prevalence on only 3 mLRBs out of the 13 individually measured variables compared to students with excess weight (Table 4.4). A higher percentage of students without excess body weight compared to students identified as either overweight or obese had not eaten vegetables at least once a day during the past 7 days (66.9% vs 68.6%; NS). A significantly higher proportion of students identified without excess body weight had drunk at least one sugar-sweetened soda during the past 7 days (60.0% vs 70.0%; the difference was significant, $X2$ (1, $N = 537$) = 5.27, $p < 0.022$), and although not statistically significant, had been currently drinking alcohol during the past 30 days (18.9% vs 14.0%; NS).

4.3. Aim 2: A Comparative Analysis of Local Findings to CDC's National and State Data Collected in the Same Year, Stratified by School Grade

Specific Aim 2 sought to compare the results obtained in the local sample to the data reported for the nation and the state of Texas by CDC in the same year. The CDC's biannual

Youth Risk Behavior Surveillance System (YRBSS) provides data for various health-related behaviors for high students through interactive tables (https://nccd.cdc.gov/Youthonline/App/Default.aspx). For this aim, specifically, the 2019 CDC YRBSS data reported for Hispanic/Latino students was used to compare the findings in the local Hispanic/Latino study population. The focus was on comparing each measurement from the local Hispanic/Latino adolescents enrolled in the 9th and 10th grades to their respective peers at the national and state levels, and one-sided binomial tests were conducted for each possible mLRB and cross-sectional intermediate outcome.

Due to the availability and compatibility of data in the national and state surveys with the original local survey used for this study, out of the 15 individual variables available in our study, only one mLRB and one outcome could not be compared. As shown for each school grade (i.e., 9th and10th grade) in the Tables 4.5 and 4.6, it was possible to directly compare 7 of the individual mLRB variables: insufficient PA, non-attendance to PE classes, not drinking milk, soda consumption, skipping breakfast, OH consumption, and short ST. Additionally, it was possible to compare cross-sectional intermediate health outcomes (3 out of 4 variables), including overweight, obesity, and symptom of depression.

Moreover, it was also possible to compare the individual mLRBs of no intake of fruit and no intake of vegetables, as well as TOB use. Although the data available in the national, state, and local survey was compatible for comparison purposes, it is important to interpret these results cautiously due to discrepancies between the local survey and the CDC YRBSS in measuring these last three mentioned concepts. Furthermore, the outcome of school performance was not included in the comparison, as no data could be found for this variable on the CDC

YRBSS website. Lastly, it was not possible to compare the recreational sedentary screen time variable as the local study combined the usage of televisions, computers, and video games.

4.3.1. Comparisons among Hispanic/Latino Adolescents Enrolled in 9th Grade: National, State, versus Local Levels

Specifically, the reported national and state data for 9th graders Hispanic/Latino adolescents in 2019 by the CDC were used to compare mLRBs and cross-sectional outcomes with the findings from the local sample of 9th graders Hispanic/Latino American adolescents residing in the U.S.-Mexico border. The results observed are described below:

a) Comparison of 9th Grader Students: National vs Local Levels

In 2019, 9th graders in the current study were significantly less likely than 9th graders at the national level to exhibit 8 mLRBs out of the 13 available variables (Table 4.5). Specifically, these 9th graders adolescents at the local level were less likely to report not being physically active for at least 60 minutes per day on all 7 days during the week before implementing the survey (66.7% vs 76.0%; significant difference, Binomial Test (one-sided, n = 237), $p< 0.001$) when compared to their peers at the national level. Similarly, a lower percentage of 9th grader local adolescents did not attend physical education classes on all 5 days in an average school week compared to national 9th grader adolescents (41.8% vs 58.3%; significant difference, Binomial Test (one-sided, n = 237), $p< 0.001$).

Regarding individual dietary behaviors of local 9th grader adolescents, compared to their peers at the national level, were less likely to report not drinking milk during the 7 days before the survey (18.5% vs 27.6%; significant difference, Binomial Test (one-sided, n = 238), $p< 0.001$) and consuming at least one sugar-sweetened soda or pop during the same period (68.1% vs 75.1%; significant difference, Binomial Test (one-sided, n = 238), $p= 0.009$). Likewise, a

lower percentage of these local students reported not eating breakfast on all 7 days of the week before implementing the survey compared to results from national students (54.6% vs 66.3%; significant difference, Binomial Test (one-sided, n = 238), p< 0.001).

Additionally, in 2019, local 9th grader adolescents were less likely than national 9th grader adolescents to report smoking cigarettes or using electronic vapor products on at least 1 day during the 30 days before the survey (20.0% vs 28.7%; significant difference, Binomial Test (one-sided, n = 215), p= 0.002). Similarly, a lower percentage of these local students reported drinking alcohol on at least 1 day during the 30 days before the survey (13.0% vs 19.1%; significant difference, Binomial Test (one-sided, n = 208), p= 0.013). The local students also had a reduced prevalence of not getting 8 or more hours of sleep on an average school night compared to national students (64.8% vs 71.0%; significant difference, Binomial Test (one-sided, n = 227), p= 0.024). In terms of two out of the three intermediate cross-sectional outcomes, although not statistically significant, local 9th grader adolescents had a lower prevalence of overweight (17.6% vs 19.5%) and obesity (16.4% vs 19.2%) when compared to their national peers.

On the contrary, the local 9th grader adolescents were significantly more likely than their national counterparts to exhibit 2 mLRBs (Table 4.5). Adolescents at the local level were more likely to report not eating fruit during the 7 days before the survey (10.1% vs 5.4%; significant difference, Binomial Test (one-sided, n = 238), p= 0.003) and not eating vegetables during the 7 days before the survey (16.5% vs 10.0%; significant difference, Binomial Test (one-sided, n = 236), p= 0.001).

Table 4.5. Comparison of mLRBs and Outcomes among Hispanic/Latino American Adolescents **Enrolled in 9th Grade**: National, State, vs Local Levels.

Greater Risk Direction:	***2019 National***[§] *9th Graders*	***2019 State***[§] *9th Graders*	***2019 Local***[§] *9th Graders*
Traditional Risk Behaviors			
Physical Activity Behaviors:			
Students who were not physically active at least 60 minutes per day on all 7 days during the 7 days before survey	76.0 (72.3 – 79.3) 747 †	81.6 (74.8 – 86.9) 259	66.7*US *TX (60.3 – 72.6) 237
Students who did not attend physical education classes on all 5 days in an average school week	58.3 (48.1 – 67.9) 665	39.6~US (25.8 – 55.3) 250	41.8*US (35.4 – 48.3) 237
Dietary Behaviors:			
Students who did not eat fruit during the 7 days before the survey	5.4 (3.5 – 8.4) 717	9.2 (5.5 – 15.0) 270	10.1*US (6.6 – 14.6) ~ 238
Students who did not eat vegetables during the 7 days before the survey	10.0 (7.6 – 13.0) 713	10.8 (7.2 – 16.0) 264	16.5*US *TX (12.0 – 21.9) ~ 236
Students who did not drink milk during the 7 days before the survey	27.6 (24.1 – 31.3) 586	31.1 (25.3 – 37.4) 258	18.5*US *TX (13.8 – 24.0) 238
Students who drank soda or pop at least 1 sugar-sweetened during the 7 days before the survey	75.1 (70.7 – 79.0) 680	72.6 (66.3 – 78.1) 268	68.1*US (61.7 – 73.9) 238
Students who did not eat breakfast on all 7 days of the week before the survey	66.3 (60.4 – 71.8) 686	72.0 (61.5 – 80.6) 259	54.6*US *TX (48.1 – 61.1) 238
Other Health Behaviors:			
Students who currently smoked cigarettes or used electronic vapor products on at least 1 day during the 30 days before the survey	28.7 (24.1 – 33.7) 692	11.9~US (8.2 – 17.0) 231	20.0*US *TX (14.9 – 26.0) 215
Students who currently drank alcohol at least 1 drink of alcohol on at least 1 day during the 30 days before the survey	19.1 (15.9 – 22.7) 697	17.8 (13.5 – 23.2) 255	13.0*US*TX (8.7 – 18.3) 208
Emerging Risk Behaviors			
Sedentary Behavior:			
Students who played, used, or watched per day 3 or more hours of recreational screen time on an average school day (television[TV] or computer[C] and video games[V])	22.9tv (18.4 – 28.3) 740 51.2cv (46.6 – 55.8) 745	25.6tv (19.1- 33.3) 257 49.4cv (42.6 – 56.2) 256	63.6tv+cv (57.1 – 69.7) ≠ 236
Sleep Behavior:			
Students who did not get 8 hours of sleep on an average school night	71.0 (68.1 – 73.8) 733	71.5 (67.6 – 75.1) 249	64.8*US *TX (58.2 – 71.0) 227
Cross-Sectional Outcomes			
Weight Status:			
Students who had obesity (BMIs were >= 95th percentile)	19.2 (15.6 – 23.5) 652	21.8 (16.7 – 27.9) 246	16.4*TX (11.9 – 21.7) 238
Students who were overweight (BMIs were >= 85th but <95th percentile)	19.5 (14.8 – 25.3) 652	19.4 (13.6 – 27.0) 246	17.6 (13.0 – 23.1) 238
Depression Symptom:			
Students who felt sad or hopeless almost every day for 2 or more weeks in a row during the past year	36.3 (32.5 – 40.4) 756	32.7 (27.3 – 38.5) 281	37.3 (31.0 – 44.0) 225

Table Footnotes:

†	Percentage (95% Confidence Interval) cell size
§	Results Among Hispanic or Latino Students
~	YRBSS and local survey had discrepancies but measured the same concept
≠	Data does not match for comparison

*US Significantly different than United States students using one-sided Binomial-Test ($p<0.05$)

*TX Significantly different than State of Texas students using one-sided Binomial-Test ($p<0.05$)

Conditions: sample proportion from binary variable against either the national or state proportion in 2019.

Analysis: One-Sample Binomial Test

~US Texas significantly different from United States ($p<0.05$); values and results from the CDC website

Regarding symptom of depression outcome, there was no statistically significant difference in the percentage of students who felt sad or hopeless almost every day for 2 or more weeks in a row during the past year (37.3% vs 36.3%) when compared to their national peers.

b) Comparison of 9th Grader Students: State vs Local Levels

In 2019, the local 9th grader adolescents were significantly less likely than state 9th grader Hispanic/Latino adolescents o engage in 5 mLRBs and 1 outcome from the 13 available variables (Table 4.5). Local adolescents were less likely to report not being physically active at least 60 minutes per day on all 7 days during the 7 days before implementing the survey (66.7% vs 81.6%; significant difference, Binomial Test (one-sided, n = 237), $p<0.001$) and not drinking milk during the 7 days before the survey (18.5% vs 31.1%; significant difference, Binomial Test (one-sided, n = 238), $p< 0.001$). Likewise, although not statistically significant, a lower percentage of local students reported consuming at least one sugar-sweetened soda or pop during the same period (68.1% vs 72.6%; NS) and a significantly lower percentage not eating breakfast on all 7 days of the week before the survey (54.6% vs 72.0%; significant difference, Binomial Test (one-sided, n = 238), $p< 0.001$) when compared to their peers at the state level.

Similarly, a lower percentage of local 9th grader adolescents reported drinking alcohol on at least 1 day during the 30 days before the survey (13.0% vs 17.8%; significant difference, Binomial Test (one-sided, n = 208), $p= 0.038$) when compared to their peers at the state level.

Also, a lower percentage of local students reported not getting 8 or more hours of sleep on an average school night (64.8% vs 71.5%; significant difference, Binomial Test (one-sided, n = 227), p= 0.016) when compared to their state peers. Moreover, regarding two out of the three intermediate outcomes, local 9th grader adolescents had a statistically significant lower prevalence of obesity (16.4% vs 21.8%; significant difference, Binomial Test (one-sided, n = 238), p< 0.023), and although not statistically significant, a lower prevalence of overweight (17.6% vs 19.4%; NS).

On the contrary, the local 9th grader adolescents were more likely than state students to exhibit 2 mLRBs out of 5 variables (Table 4.5). A higher percentage of local students were more likely than state students to not eating vegetables during the 7 days before the survey (16.5% vs 10.8%; significant difference, Binomial Test (one-sided, n = 236), p= 0.005), smoking cigarettes or using electronic vapor products on at least 1 day during the 30 days before the survey (20.0% vs 11.9%; significant difference, Binomial Test (one-sided, n = 215), p< 0.001), and although not statistically significant, feeling sad or hopeless almost every day for 2 or more weeks in a row during the past year (37.6% vs 32.7%; NS). Although not statistically significant, adolescents at the local level were more likely to report not attending physical education classes on all 5 days in an average school week (41.8% vs 39.6%; NS), and not eating fruit during the 7 days before the survey (10.1% vs 9.2%; NS) when compared to their peers at the state level.

4.3.2. Comparisons among Hispanic/Latino Adolescents Enrolled in 10th Grade: National, State, versus Local Levels

The reported national and state data for 10th graders Hispanic/Latino adolescents in 2019 by the CDC were used to compare mLRBs and cross-sectional outcomes with the findings from

the local sample of 10th graders Hispanic/Latino American adolescents residing in the U.S.-Mexico border. The results observed are described below:

a) Comparison of 10th Grader Students: National vs Local Levels

Local 10th grader adolescents were significantly less likely than the national 10th grader adolescents to exhibit 7 mLRBs and 1 outcome out of the 13 available variables (Table 4.6). Students at the local level were less likely to report not being physically active at least 60 minutes per day on all 7 days during the 7 days before the survey (72.0% vs 79.1%; significant difference, Binomial Test (one-sided, n = 300), p= 0.002) compared to the students at the national level. Similarly, a lower percentage of 10th grader adolescents did not attend physical education classes on all 5 days in an average school week (58.3% vs 71.9%; significant difference, Binomial Test (one-sided, n = 300), p< 0.001).

Moreover, regarding dietary behaviors, local 10th grader adolescents, compared to national 10th grader Hispanic/Latino adolescents, were less likely to report not eating fruit during the 7 days before the survey (5.0% vs 5.9%; non-significant difference), not drinking milk during the 7 days before the survey (21.1% vs 27.8%; significant difference, Binomial Test (one-sided, n = 299), p= 0.005), and consuming at least one sugar-sweetened soda or pop during the same period (65.9% vs 75.8%; significant difference, Binomial Test (one-sided, n = 299), p= 0.015). Likewise, although not statistically significant, a smaller percentage of these local students reported not eating breakfast on all 7 days of the week before the survey (64.8% vs 68.2%; NS) compared to their national peers (Table 4.6).

Table 4.6. Comparison of mLRBs and Outcomes among Hispanic/Latino American Adolescents **Enrolled in 10th Grade**: National, State, vs Local Levels.

Greater Risk Direction:	***2019 National***[§] *10th Graders*	***2019 State***[§] *10th Graders*	***2019 Local***[§] *10th Graders*
Traditional Risk Behaviors			
Physical Activity Behaviors:			
Students who were not physically active at least 60 minutes per day on all 7 days during the 7 days before survey	79.1 (73.8 – 83.6) 775	76.6 (70.2 – 82.0) 295	72.0*US *TX (66.6 – 77.0) 300
Students who did not attend physical education (PE) classes on all 5 days in an average school week	71.9 (64.6 – 78.3) 703	68.4 (57.0 – 77.8) 292	58.3*US *TX (52.5 – 64.0) 300
Dietary Behaviors:			
Students who did not eat fruit during the 7 days before the survey	5.9 (3.5 – 9.9) 753	7.1 (4.5 – 11.0) 301	5.0 (2.8 – 8.1) ~ 300
Students who did not eat vegetables during the 7 days before the survey	9.3 (6.0 – 14.1) 741	9.9 (6.7 – 14.4) 292	9.4 (6.3 – 13.2) ~ 299
Students who did not drink milk during the 7 days before the survey	27.8 (24.3 – 31.7) 649	30.8 (23.6 – 39.1) 292	21.1*US *TX (16.6 – 26.1) 299
Students who drank soda or pop at least 1 sugar-sweetened during the 7 days before the survey	71.8 (66.6 – 76.4) 721	75.5 (69.3 – 80.7) 295	65.9*US *TX (60.2 – 71.2) 299
Students who did not eat breakfast on all 7 days of the week before the survey	68.2 (61.6 – 74.2) 736	68.0 (60.6 – 74.6) 293	64.8 (59.0 – 70.2) 298
Other Health Behaviors:			
Students who currently smoked cigarettes or used electronic vapor products on at least 1 day during the 30 days before the survey	33.9 (28.3 – 40.0) 716	14.5~US (10.5 – 19.7) 260	24.7*US *TX (19.8 – 30.5) 279
Students who currently drank alcohol at least 1 drink of alcohol on at least 1 day during the 30 days before the survey	29.1 (23.0 – 36.1) 709	25.8 (20.7 – 31.7) 287	20.7*US*TX (16.1 – 26.0) 275
Emerging Risk Behaviors			
Sedentary Behavior:			
Students who played, used, or watched per day 3 or more hours of recreational screen time on an average school day (television[TV] or computer[C] and video games[V])	22.0tv (18.5 – 25.9) 767 46.1cv (41.9 – 50.4) 770	16.6tv (12.7 – 21.5) 295 46.0cv (36.8 – 55.5) 295	61.9tv+cv (56.1 – 67.4) ≠ 299
Sleep Behavior:			
Students who did not get 8 hours of sleep on an average school night	76.1 (70.8 – 80.7) 765	78.2 (73.6 – 82.2) 293	63.7*US *TX (57.9 – 69.2) 292
Cross-Sectional Outcomes			
Weight Status:			
Students who had obesity (BMIs were >= 95th percentile*)	18.6 (13.8 – 24.5) 692	15.9 (12.2 – 20.5) 285	15.6 (11.7 – 20.2) 301
Students who were overweight (BMIs were >= 85th but <95th percentile*)	19.8 (15.5 – 24.9) 692	17.5 (14.6 – 20.9) 285	14.0*US (10.2 – 18.4) 301
Depression Symptom:			
Students who felt sad or hopeless almost every day for 2 or more weeks in a row during the past year	40.2 (36.1 – 44.5) 791	39.0 (31.2 – 47.3) 310	43.0 (37.2 – 48.9) 291

Table Footnotes:

†	Percentage (95% Confidence Interval) cell size
§	Results Among Hispanic or Latino Students
~	YRBSS and local survey had discrepancies but measured the same concept
≠	Data does not match for comparison

*US Significantly different than United States students using one-sided Binomial-Test ($p<0.05$)
*TX Significantly different than State of Texas students using one-sided Binomial-Test ($p<0.05$)
Conditions: sample proportion from binary variable against either the national or state proportion in 2019.
Analysis: One-Sample Binomial Test
~US Texas significantly different from United States ($p<0.05$); values and results from the CDC website

Regarding smoking cigarettes or using electronic vapor products, local students were less likely than national students to use these products at least 1 day during the 30 days before the survey (24.7% vs 33.9%; significant difference, Binomial Test (one-sided, n = 279), $p< 0.001$). Similarly, a smaller percentage of these local students reported drinking alcohol on at least 1 day during the 30 days before the survey (20.7% vs 29.1%; significant difference, Binomial Test (one-sided, n = 275), $p= 0.001$). Local students also had a lower prevalence of not getting 8 or more hours of sleep on an average school night compared to their peers at the national level (63.7% vs 76.1%; significant difference, Binomial Test (one-sided, n = 292), $p< 0.001$). In addition, there was a lower prevalence of overweight local students (14.0% vs 19.8%; significant difference, Binomial Test (one-sided, n = 301), $p= 0.005$) and a similar but not statistically significant trend for obesity (15.6% vs 18.6%; NS) when compared to their peers at the national level. (Table 4.6).

On the contrary, although not statistically significant, the local 10th grader Hispanic/ Latino adolescents were more likely than the national students to present 2 out of the 13 available variables. On the variable of not eating vegetables during the 7 days before implementing the survey (9.4% vs 9.3%; NS) local and national results were similar. Regarding symptom of depression outcome, local and national results showed no statistical difference;

however, local students showed a higher percentage than their national counterparts (43.0% vs 40.2%; NS) (Table 4.6).

b) Comparison of 10th Grader Students: State vs Local Levels

The local 10th grader adolescents were significantly less likely than the state 10th grader adolescents to exhibit 6 mLRBs out of the 13 available variables (Table 4.6). Specifically, students at the local level were more likely to report not being physically active for at least 60 minutes per day on all 7 days during the 7 days before the survey (72.0% vs 76.6%; significant difference, Binomial Test (one-sided, n = 300), p= 0.037) and not attending physical education classes on all 5 days in an average school week (58.3% vs 68.4%; significant difference, Binomial Test (one-sided, n = 300), p< 0.001) when compared to their peers at the state level.

Regarding the individual dietary behaviors, state students show a higher prevalence of not drinking milk during the 7 days before the survey (21.1% vs 30.8%; significant difference, Binomial Test (one-sided, n = 299), p< 0.001) when compared to local students. Although not statistically significant, local students, were less likely to report not eating fruit during the 7 days before the survey (5.0% vs 7.1%; NS), and not eating vegetables during the 7 days before the survey (9.4% vs 9.9%; non-significant difference).

A lower percentage of local students reported consuming at least one sugar-sweetened soda or pop during the same period (65.9% vs 75.5%; significant difference, Binomial Test (one-sided, n = 299), p< 0.001) and not eating breakfast on all 7 days of the week before the survey (64.8% vs 68.0%; NS) when compared to their peers at the state level (Table 4.6).

Additionally, more students from the state level report drinking alcohol, at least 1 alcoholic beverage on at least 1 day during the 30 days before the survey (20.7% vs 25.8%; significant difference, Binomial Test (one-sided, n = 275), p= 0.030) when compared to local

students. Local students also showed better sleep behaviors when compared to their state peers. Students at the state level showed that 78.2% reported not getting 8 or more hours of sleep on an average school night against 63.7% from the local students (significant difference, Binomial Test (one-sided, n = 292), p< 0.001). Regarding body weight status outcomes, local students showed a lower prevalence on overweight (14.0% vs 17.5%; NS) and similar outcome on obesity (15.6% vs 15.9%; NS) when compared to their state peers. (Table 4.6).

On the contrary, 10th grader adolescents were significantly more likely than state students to exhibit 1 mLRBs out of the 13 available variables (Table 4.6). Students at the local level were more likely to report smoking cigarettes or using electronic vapor products on at least 1 day during the 30 days before the survey (24.7% vs 14.5%; significant difference, Binomial Test (one-sided, n = 279), p< 0.001). Regarding symptom of depression outcome, the results were not statistically significant; however, 43% of the local students reported feeling sad or hopeless almost every day for 2 or more weeks in a row during the past year when compared to 39% of their peers at the state level.

4.4. Aim 3: Local Sample's Compliance with the Concept of 24-Hour Movement Behaviors

Specific Aim 3 was conducted to assess the extent to which local Hispanic/Latino adolescents met the recommended guidelines for a 24-hour daily cycles of integrating habitual movement and non-movement behaviors. This 24-hour movement behavior (24-h MBs) concept comprises three interrelated and codependent behaviors: physical activity (PA), recreational sedentary screen time (RSST), and sleep time (ST). Out of the 539 students in the local sample, a total of 531provided complete data and were included in the analysis to evaluate the compliance of Hispanic/Latino American adolescents residing in the U.S.-Mexico border with this trendy concept, which recognizes the collective impact of these lifestyle behaviors on adolescent health.

Table 4.7. Estimated Prevalence of Local Hispanic/Latino Adolescents Meeting PA, RSST, and ST According to CDC Recommendations.

Characteristics	Healthy 24-hour Habitual Behaviors % (n), (95% CI)		
	PA	RSST	ST
Overall	30.4 (163) (26.51 – 34.29)	37.4 (200) (33.29 – 41.50)	35.8 (186) (31.67 – 39.92)
Sex:			
Female	20.2 (52) (16.80 – 23.59)	37.5 (96) (33.39 – 41.60)	30.8 (76) (26.83 – 34.77)
Male	39.8 (111) (35.65 – 43.94)	37.3 (104) (33.20 – 41.39)	40.4 (110) (36.17 – 44.62)
School Grade:			
9th grade	33.3 (79) (29.31 – 37.28)	36.4 (86) (32.32 – 40.47)	35.2 (80) (31.09 – 39.31)
10th grade	28.0 (84) (24.20 – 31.79)	38.1 (114) (33.98 – 42.21)	36.3 (106) (32.16 – 40.43)
Weight Status:			
BMI <85th percentile	32.2 (118) (28.25 – 36.15)	37.8 (138) (33.69 – 41.90)	38.4 (137) (34.21 – 42.58)
BMI ≥85th percentile	26.5 (45) (22.76 – 30.23)	36.5 (62) (32.42 – 40.57)	30.2 (49) (26.25 – 34.15)

Notes: CDC's recommendations are: Physical Activity (PA) 60 minutes or more every day; Recreational Sedentary Screen Time (RSST) 2 hours or less each day, and Sleep Time (ST) 8 hours or more per night.

When examining each specific healthy behavior in 24-hour period and its compliance with CDC's recommendations for adolescents in the local sample, it was found that 37.4% (95% CI 33.29, 41.50) of adolescents adhered to the recreational sedentary screen time guideline (i.e., less than two hours per day of use of television, computer, or video games for non-school purposes) on an average school day. This was followed by 35.5% (95% CI 31.67, 39.92) meeting the sleep time guideline that recommends 8 or more hours per night, and 30.4% (95% CI 26.51, 34.29) meeting the physical activity guideline, which recommends at least 60 minutes of activity per day (Table 4.7).

Additionally, it was observed that students classified as overweight or obese based on the BMI-for-Age (i.e., above the 85th percentile) were less likely to meet any specific CDC

guidelines for physical activity, limiting recreational screen time, and sleep time when compared to students with BMI-for-Age below the 85th percentile (Table 4.7). There were no other consistent patterns of differences observed in other subgroups. Females showed a lower likelihood of meeting physical activity and sleep time guidelines when compared to male; whereas 9th graders showed a lower likelihood of meeting the guidelines for limiting recreational screen time and sleep time when compared to 10th graders.

Table 4.8. Estimated prevalence of local Hispanic/Latino adolescents meeting Zero to all 24-hour Habitual Behavior Guidelines (PA, RSST, ST).

Characteristics	Unweighted sample size n	Meeting the Healthy 24-hour Habitual Guidelines % (n), (95% CI)			
		0	1	2	3
Overall	531	31.5 (167) (27.54 – 35.45)	39.5 (210) (35.34 – 43.65)	23.2 (123) (19.61 – 26.79)	5.8 (31) (3.81 – 7.78)
Sex:					
Female	256	38.7 (99) (32.73 – 44.66)	37.9 (97) (31.95 – 43.84)	20.7 (53) (15.74 – 25.66)	2.7 (7) (0.71 – 4.68)
Male	275	24.7 (68) (19.60 – 29.79)	41.1 (113) (35.28 – 46.91)	25.5 (70) (20.35 – 30.65)	8.7 (24) (5.37 – 12.03)
School Grade:					
9th grade	234	32.5 (76) (26.49 – 38.50)	37.6 (88) (31.39 – 43.80)	22.6 (53) (17.24 – 27.96)	7.3 (17) (3.96 – 10.63)
10th grade	297	30.6 (91) (25.36 – 35.84)	41.1 (122) (35.50 – 46.69)	23.6 (70) (18.77 – 28.43)	4.7 (14) (2.29 – 7.11)
Weight Status:					
BMI <85th percentile	363	30.0 (109) (25.28 – 34.71)	38.3 (139) (33.29 – 43.30)	25.1 (91) (20.64 – 29.56)	6.6 (24) (4.05 – 9.15)
BMI ≥85th percentile	168	34.5 (58) (27.31 – 41.68)	42.3 (71) (34.83 – 49.77)	19.0 (32) (13.07 – 24.93)	4.2 (7) (1.16 – 7.23)

Notes: CDC's recommendations are: Physical Activity (PA) 60 minutes or more every day; Recreational Sedentary Screen Time (RSST) 2 hours or less each day, and Sleep Time (ST) 8 hours or more per night.

Table 4.8 presents the estimated prevalence of local Hispanic/Latino adolescents meeting the guidelines collectively for the 24-hour movement behavior (24-h MB) concept, as well as only meeting two, one, and none of these CDC guidelines. Overall, more than half (68.5%) of the local sample met at least one of these healthy movement/ non-movement habitual behaviors across the whole day. In general, only 5.8% (95% CI,

3.81 – 7.78) of local adolescents met all three healthy behaviors simultaneously for the 24-h MB concept (Figure 4.2). Meanwhile, 23.2% (95% CI, 19.6 – 26.8) met two, 39.5% (95% CI, 35.3 – 43.8) met one, and 31.5% (95% CI, 27.54 – 35.45) did not meet any of these behaviors, as depicted in Figure 4.2, illustrating a Venn diagram showcasing the interrelation of these three behaviors in our local sample.

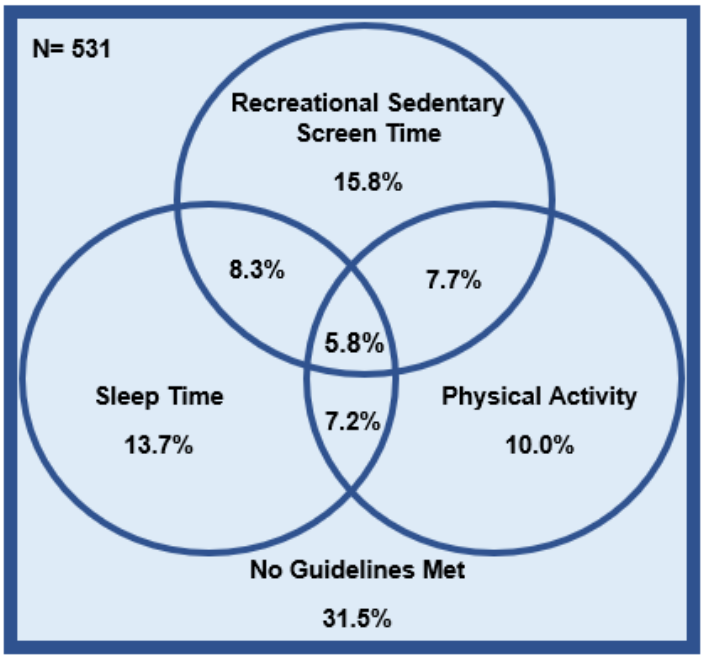

Figure 4.2. Proportions of local Hispanic/Latino American adolescents that individually or jointly adhere to the healthy 24-hour habitual behavior guidelines.

Additionally, male adolescents exhibited the highest prevalence of meeting all three guidelines for the 24-hour MB concept at 8.7% (95% CI 5.37 – 12.03) when compared to females (2.7%, 95% CI 0.71 – 4.68). Their corresponding patterns are visually depicted in Figure 4.3 which illustrates the interrelationships among the three 24-hour MBs and their prevalence. Similarly, the highest prevalence was observed among 9th graders (7.3%, 95% CI 3.96 – 10.63) compared to 10th graders (4.7%, 95% CI 2.29 – 7.11), and among students with BMI-for-age under the 85th percentile (6.6%, 95% CI

4.05 – 9.15) compared to students classified as overweight or obese (4.2%, 95% CI 1.16 – 7.23). Their corresponding prevalence and patterns are depicted in Figure 4.4 and 4.5. The difference in percentages was statistically significant only between males and females (Pearson Chi-Square-Test (1, N=531) = 8.662, p= 0.003) (Table 4.8).

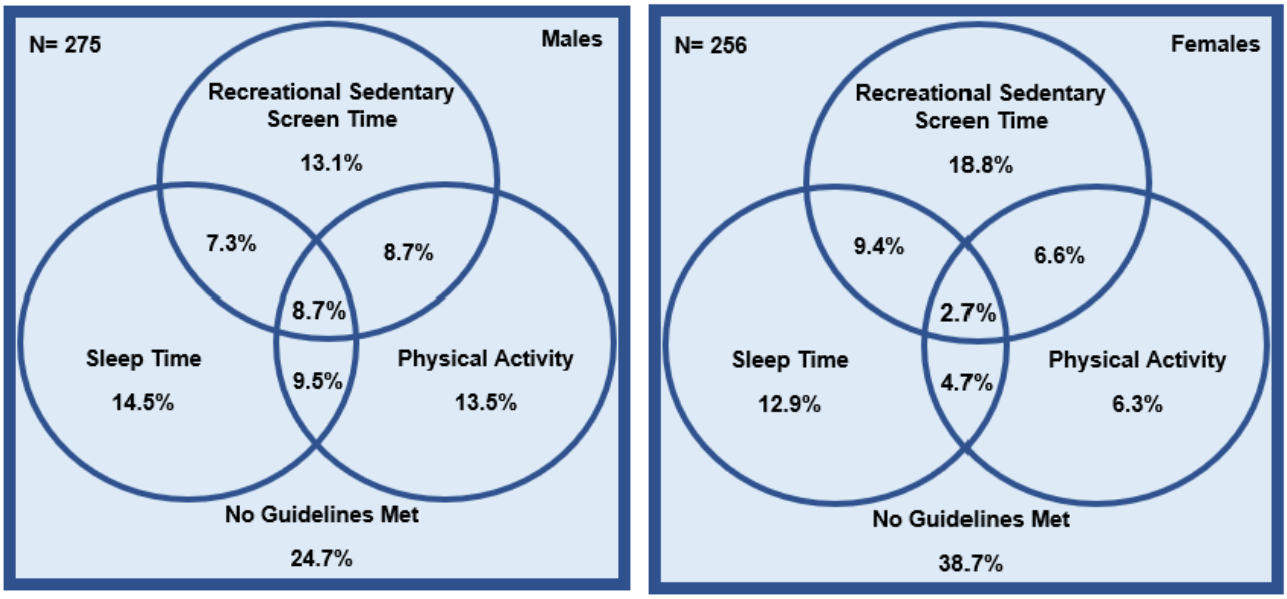

Figure 4.3. Proportions of local Hispanic/Latino American adolescents stratified by sex that individually or jointly comply to the 24-hour movement behavior guidelines.

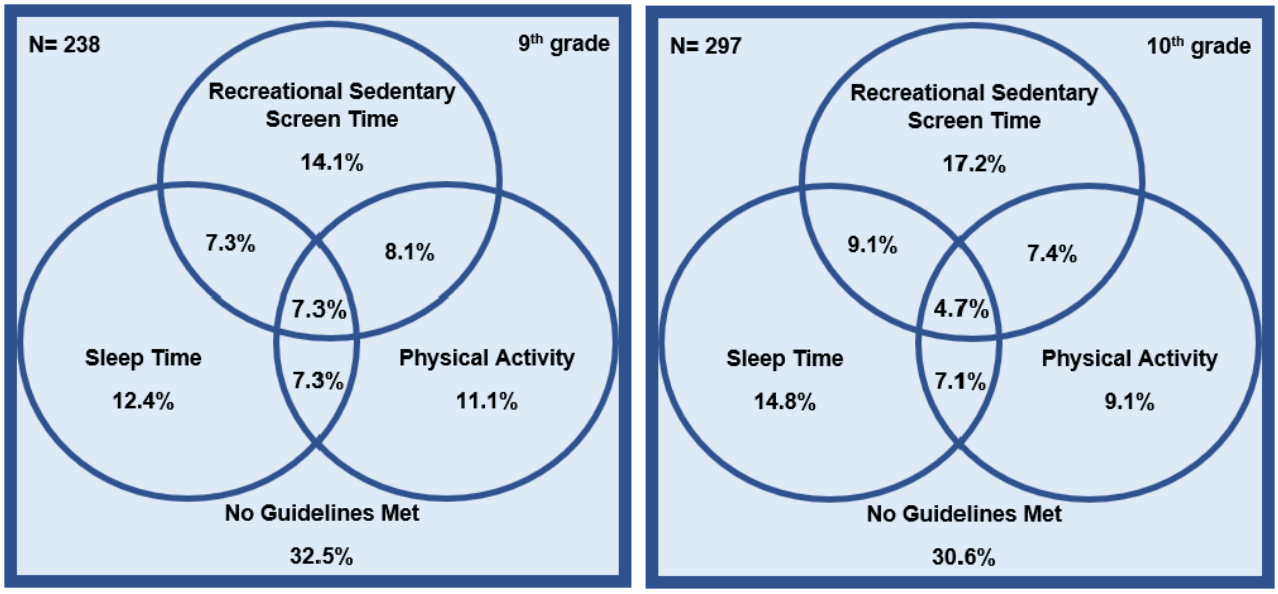

Figure 4.4. Proportions of local Hispanic/Latino adolescents stratified by school grade that individually and jointly comply to the 24-hour movement behavior guidelines.

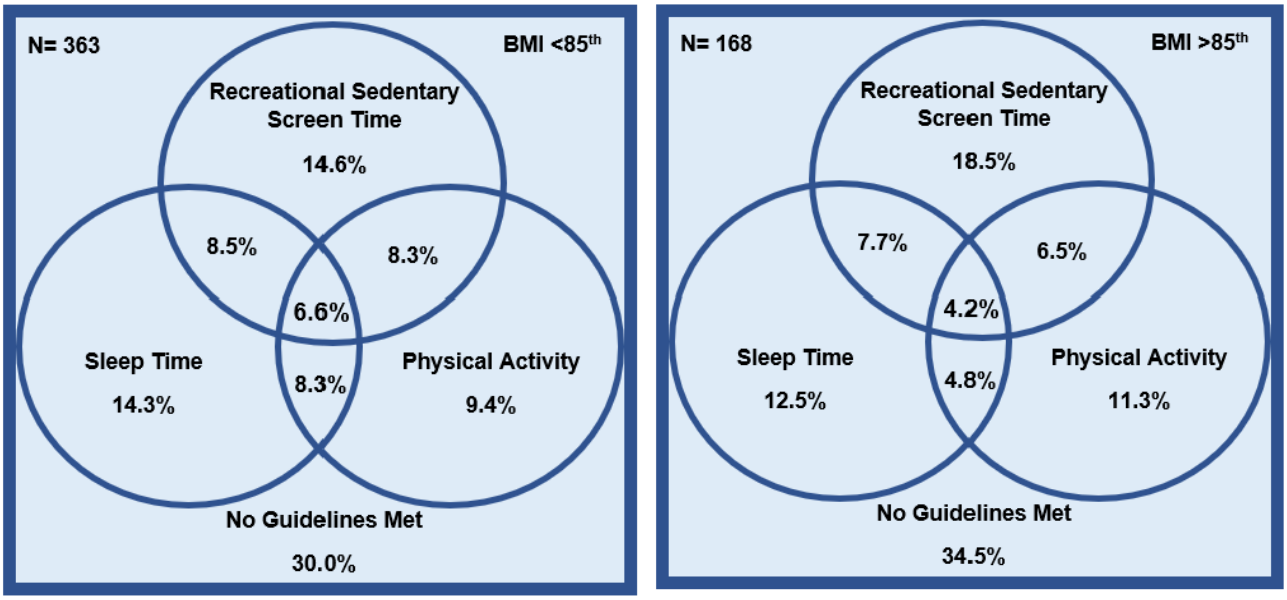

Figure 4.5. Proportions of local Hispanic/Latino adolescents stratified by weight status that individually and jointly comply to the 24-hour movement behavior guidelines.

Furthermore, when comparing the overall prevalence of the 24-h MB concept in the local sample to the values reported from a nationally representative sample of US Hispanic/Latino high school-aged students acquired from four previous cycles (i.e., 2011, 2013, 2015, 2017) of CDC YRBSS data (Knell et.al., 2019), we found that the overall prevalence of 5.8% (95% CI 4.0, 8.2) in the local sample was significantly higher than the 4.0% (95% CI 3.5, 4.4) from the national representative value (One-Sample Binomial Test, p= 0.025).

When stratified by sex, the prevalence among local females of 2.7% (95% CI 1.1, 5.6) was not significantly different from their national peers' value of 2.5% (95% CI 2.0, 3.0) (One-Sample Binomial Test, p= 0.458). Conversely, the prevalence among local males of 8.7% (95% CI 5.7, 12.7) was significantly higher than the 5.4% (95% CI 4.7, 6.1) from the national male representative value (One-Sample Binomial Test, p= 0.015).

Lastly, logistic regression modeling was conducted to evaluate the relationship between weight status and meeting all three healthy 24-hour habitual behavior guidelines (i.e., PA, RSST, and ST). After adjusting for sex and school grade, no statistically significant association was found between body weight status and meeting all three CDC's movement guidelines from the 24-h MB concept among the local sample (B = -0.56, p = 0.209).

4.5. Aim 4: Traditional and Emerging mLRBs: A Two-Step Cluster Analysis among a Local Sample of Hispanic/Latino American Adolescents

Specific Aim 4 sought to provide valuable insights into potential underlying patterns within the local sample of in-school Hispanic/Latino adolescents. The objective was to perform a two-step cluster (TSC) analysis to identify and classify the local cases into homogeneous groups or clusters based on engagement similarities in terms of the mLRBs associated to NCDs. The included factors were the four traditional behaviors (insufficient PA, unhealthy DIET, TOB use, OH consumption) and the two emerging behaviors (increased RSST, and short ST). The TSC findings are reported from both the original dataset and a newly imputed dataset using multiple imputation by chain equation technique (n = 454 and n = 539, respectively).

4.5.1. Original Dataset Findings

The TSC analysis was based on six mLRBs related to NCD (insufficient PA, unhealthy Diet, TOB use, OH consumption, as well as increased RSST and reduced ST), and resulted in the identification of five distinct and well-defined clusters. In this initial TSC analysis where the original dataset was used, the six previously mentioned mLRBs were incorporated as input variables. However, due to missing values, a total of 85 cases of adolescents were excluded from the analysis, resulting in a sample containing 454 students thus accounting for 84.2% of the sample. The five cluster sizes were as follows: 13.0% (n=59), 15.4% (n=70), 19.8% (n=90),

23.3% (n=106), and 28.4% (n=129), showing a good ratio of sizes with a value of 2.19 from the largest to the smallest clusters.

Figure 4.6 displays the quality of the clusters derived from this study, and it is deemed acceptable, as it is classified as a fair value. In other words, this fair classification suggests that the current members of each cluster are relatively close to their respective cluster centers, and the proximity of the cases to their respective cluster centers indicates a reasonable level of cohesion within each cluster. In essence, the results imply that the students within the same cluster exhibit greater similarity in traits to each other while being more distinct from those in other clusters.

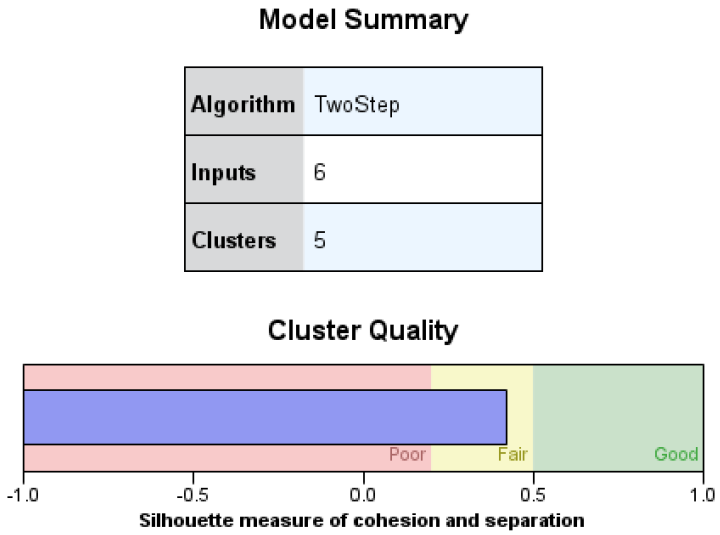

Figure 4.6. Model summary and clusters quality assessment in the two-step cluster analysis using the original dataset (n=454).

The average silhouette coefficient of 0.4 suggests a fair level of clustering quality. The cluster distributions are also satisfactory, with each group having over 50 individuals. Also, the predictor values for the six inputs are deemed acceptable. Among the six mLRBs, unhealthy Diet (1.00) emerged as the most influential predictor variable, followed by TOB use (0.87), OH

consumption (0.73), insufficient PA (0.62), reduced ST (0.44), and increased RSST as the least significant predictor (0.07).

The five distinct clusters obtained from the TSC analysis consistently appeared across different case orders (i., ascending, descending, and random), confirming the stability of the clustering results in the original dataset (Figure 4.7). Detailed information on the distribution and characteristics of each cluster is presented in Table 4.9. Marking mLRBs as at risk indicates a potential increased risk for NCDs as the students did not meet the established CDC standard recommendations.

Table 4.9. Clusters characteristics in terms of modifiable Lifestyle Risk Behaviors for Non-Communicable Diseases among a local sample of Hispanic/Latino American adolescents in 2019, based on original dataset (N = 454).

Cluster #:	**3**	**2**	**1**	**5**	**4**
At Risk:	**2 mLRBs**	**3 mLRBs-E**	**3 mLRBs-T**	**4 mLRBs**	**6 mLRBs**
Size:	**19.8%** (n=90)	**15.4%** (n=70)	**13.0%** (n=59)	**28.4%** (n=129)	**23.3%** (n=106)
Inputs (importance)					
Diet (1.00)	**No** (100%)	**At risk** (100%)	**At risk** (100%)	**At risk** (100%)	**At risk** (90.6%)
TOB (0.87)	**No** (93.3%)	**No** (100%)	**No** (100%)	**No** (100%)	**At risk** (86.8%)
OH (0.73)	**No** (98.9%)	**No** (100%)	**No** (100%)	**No** (100%)	**At risk** (71.7%)
PA (0.62)	**At risk** (53.3%)	**No** (100%)	**At risk** (100%)	**At risk** (100%)	**At risk** (73.6%)
ST (0.44)	**At risk** (56.7%)	**At risk** (55.7%)	**No** (100%)	**At risk** (100%)	**At risk** (66.0%)
RSST (0.07)	**No** (62.2%)	**At risk** (54.3%)	**At risk** (66.1%)	**At risk** (68.2%)	**At risk** (73.6%)

Cluster No.3 was labeled as “2 mLRBs” as it exhibited 1 traditional and 1 emergent modifiable lifestyle risk behaviors (mLRBs) as at-risk and represented 19.8% (90) of the original sample. Within this cluster, more than half of its members did not meet the recommended levels for physical activity (53%) and had reduced sleep time (57%). Nonetheless, all the members in this group met three or more of the six recommended dietary guidelines (100%), most of them were identified as non-smokers (93%), and did not consume alcohol (99%), as well as over half of them met the recommended levels of recreational sedentary screen time (62%), as displayed in

Table 4.9. Additionally, the '2 mLRBs' cluster was characterized by a roughly equal distribution with about half being male (54%) and students enrolled in 10th grade (56%).

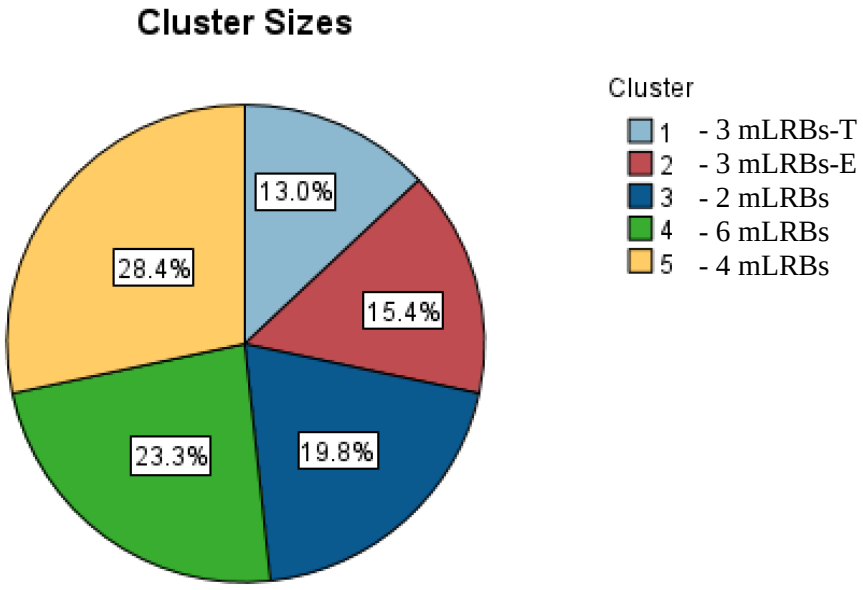

Figure 4.7. Pie chart displaying the percentage distribution of cases among the five identified clusters from the TSC analysis conducted on the original dataset (n = 454).

Cluster No.2 represented 15.4% (70) of the local sample of adolescents and was labeled as "3 mLRBs-E" since it exhibited 1 traditional and 2 emergent mLRBs marked as at-risk behaviors. Within this cluster, all members did not meet the recommendation of at least 3 dietary behaviors (100%). Additionally, more than half of its members did not meet the recommended sleep time (56%) and had increased recreational sedentary screen time (54%). The members of this group adhered to 3 key recommendations; all the adolescents were identified as non-smokers (100%), did not consume alcohol (100%), and engaged in physical activity for at least 60 minutes per day (100%), as displayed in Table 4.9. This "3 mLRBs-E" cluster predominantly consisted of males (70%) and had a nearly equal school grade distribution, with about half of the students being enrolled in the 9th grade (53%).

Cluster No. 1 was the smallest cluster, comprising only 13.0% (59) of the original sample (n =454) and was labeled as "3 mLRBs-T". This cluster also exhibited a total of 3 mLRBs, consisting of 2 traditional and 1 emergent mLRBs marked as at-risk behaviors. Within this cluster, none of the adolescents met the recommendations for physical activity (100%) and failed to meet at least 3 dietary guidelines (100%), as well as over half of them had an increased recreational sedentary screen time (66%). Additionally, all members did not meet the recommendation of at least 3 dietary behaviors (100%). Like the previous cluster, and despite these 3 risk behaviors, all adolescents this cluster within the "3 mLRBs-T" group adhered to 3 key recommendations: they did not use tobacco (100%), did not consume alcohol (100%), and slept for 8 hours or more per night (100%) as shown in Table 4.9. The "3 mLRBs-T" cluster was characterized by a roughly equal sex distribution with about half being females (53%) and more than half were 10th grade students (63%).

The largest group was Cluster No. 5, comprising 28.4% (129) of adolescents. This cluster was labeled as "4 mLRBs" as it exhibited 2 traditional and 2 emergent mLRBs marked as at-risk behaviors. Within this cluster, none of its members met the recommendation for physical activity (100%), did not meet at least three dietary guidelines (100%), and all had a reduced sleep time (100%). Additionally, over half of the adolescents in this cluster had increased recreational sedentary screen time (68%). Even though all adolescents within this cluster did not use tobacco (100%) or consume alcohol (100%), the "4 mLRBs" cluster had the presence of 4 out of the 6 mLRBs marked as at-risk behaviors. Additionally, it was observed that more than half of the group consisted of females (60%) and enrolled in 10th grade (57%).

Lastly, Cluster No.4 exhibited all mLRBs marked as at-risk behaviors and was labeled as "6 mLRBs" representing 23.3% (106) of the students in the local sample. Results indicate that

most of the adolescents in this cluster did not meet most of the CDC's recommendations. Most of its members did not meet the four traditional mLRBs consisting of at least three or more risk factors including: dietary behaviors (91%), insufficient physical activity (74%), engaged in tobacco use (87%), and alcohol consumption (72%), as displayed in Table 4.9. Similarly, many of the students displayed the two emerging mLRBs such as an increased recreational sedentary screen time (74%) and did not meet the recommended sleep time (66%). In addition, it was observed that the "6 mLRBs" cluster comprised of approximately half males (53%) and about two-thirds students were enrolled in 10^{th} grade (65%).

Lastly, after completing the TSC analysis, it was observed that 52% (n= 235) of the local sample were clustered within the groups exhibiting 4 and 6 mLRBs marked as at-risk behaviors. Moreover, separate analyses were conducted for males and females using the original dataset (n = 454), as exhibited in Table 4. 9. However, it was observed that stratifying the sample by sex resulted in the TSC analysis being sensitive to the initial order of the cases (i.e., ascending or descending); meaning there was not enough stability of the clustering results. Further analyses will be needed to better understand the configuration of these groups.

4.5.2. Imputed Dataset Findings

In the current study, multivariate imputation by chained equations was utilized before performing the following Two-Step Cluster (TSC) analysis. Multiple imputation (MI) was employed to ensure the inclusion of all possible cases in this analysis, as well as to improve statistical power, reduce bias, and enable more accurate inferences since it effectively handles missing data. Multiple imputation in SPSS is a statistical technique that generates multiple plausible imputed datasets, each with different plausible values for missing data, based on observed data and underlying patterns.

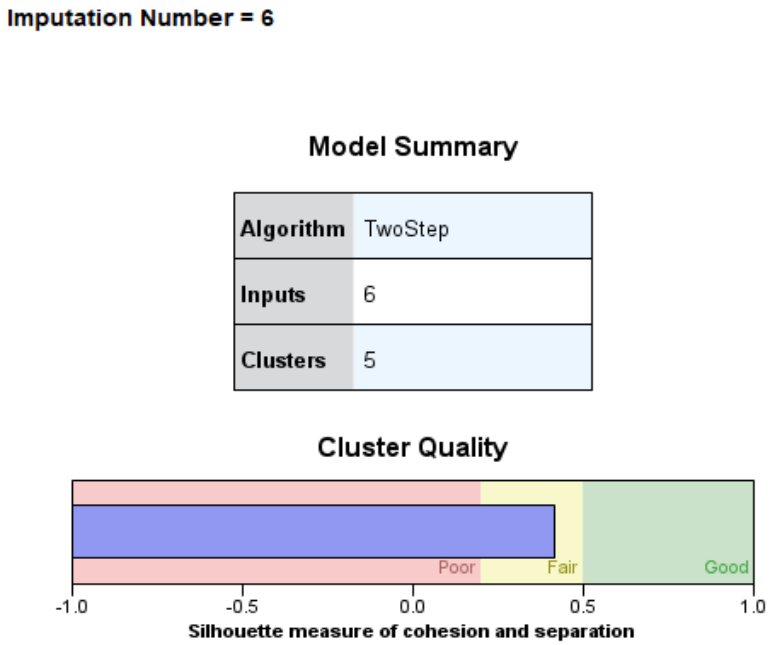

Figure 4.8. Model summary and clusters quality assessment in the two-step cluster analysis using the multiple imputed dataset (n = 539).

The TSC analysis function is not yet supported to calculate a pooled output based on the 20 imputed datasets by IBM SPSS Statistic version 28.0. After performing the TSC analysis on the 20 multiple imputed datasets, it was observed that datasets 2, 6, and 9 showed stability and presented the same group distribution as the original data. Following the same procedures and input order as with the original data, these imputed datasets exhibited similar cluster parameters. Nonetheless, based on dataset stability, group balance, and as representative of the original data group distribution, the MI.6 dataset was chosen, and their specific TSC results are shown in Figure 4.8.

As displayed in the model summary and cluster quality derived from the imputed dataset (n = 539), it is deemed to be an acceptable model, as it is classified as a fair value (Figure 4.8). In other words, this fair classification suggests that the current members of each cluster are relatively close to their respective cluster centers, and the proximity of the cases to their

respective cluster centers indicates a reasonable level of cohesion within each cluster, as well as a reasonable separation from the other clusters.

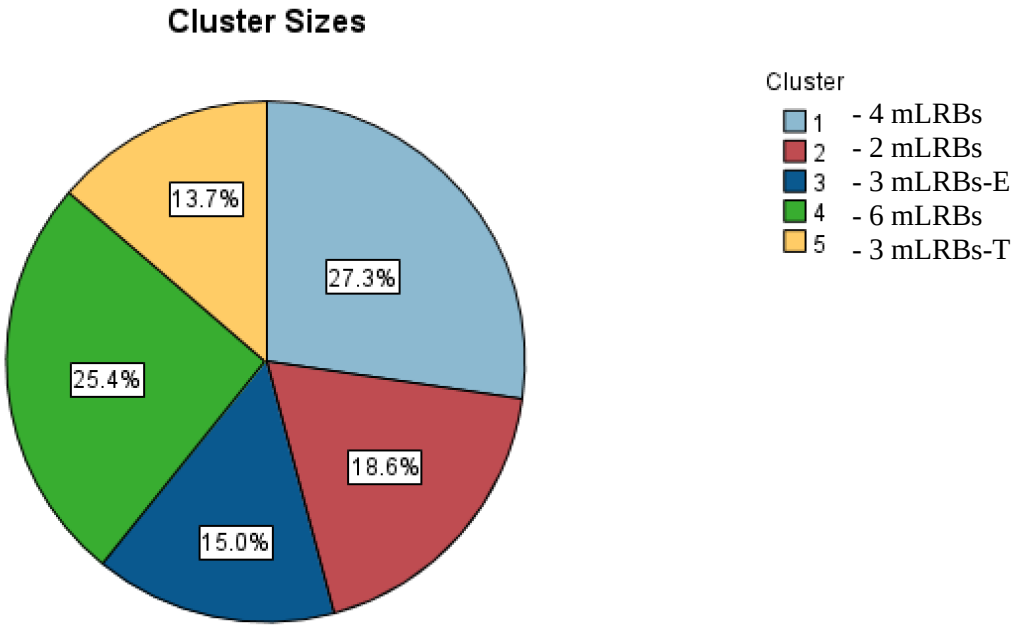

Figure 4.9. Percentage distribution among the five identified clusters from a Two Step Cluster analysis conducted on the Multiple Imputed dataset (n = 539).

Five well-defined clusters were identified on the imputed dataset through the TSC analysis (Figure 4.9), using the combination of 4 traditional and 2 emerging mLRBs, including insufficient physical activity (PA), unhealthy dietary behaviors (Diet), tobacco use (TOB), alcohol consumption (OH), increased recreational sedentary screen time (RSST), and reduced sleep time (ST). The sizes of the clusters from the smallest to the largest were 13.7% (n=74), 15.0% (n=81), 18.6% (n=100), 25.4% (n=137), and 27.3% (n=147); with a good ratio of sizes of 1.99 from largest to smallest clusters. The quality of the clusters showed an average silhouette coefficient of 0.4 which indicated a fair level, and the cluster distributions sizes are over 74 members per group. In terms of predicting values for the 6 mLRBs, the most influential predictor

variable was unhealthy diet (1.00), followed by TOB use (0.81), OH consumption (0.78), insufficient PA (0.62), reduced ST (0.46), and increased RSST (0.05) as the least important.

The TSC analysis on the imputed dataset confirmed the presence of the previously identified five clusters, with consistent groupings observed across analyses conducted with different case orders (i.e., ascending, descending, and random). Table 4.10 provides specific information on the distribution and characteristics within each cluster. Among these 5 clusters, the one with the fewest risk behaviors was Cluster No. 2, labeled "2 mLRBs," and comprised 18.6% (100) of the adolescents from the local sample. Within this cluster, 1 traditional and 1 emergent mLRBs prevailed; specifically, over half of its members did not meet the recommended guidelines for physical activity (55%) and had reduced sleep time (57%). Nonetheless, all these adolescents met three or more of the recommended dietary guidelines (100%). A majority of the cluster's members did not smoke (91%), did not consume alcohol (99%), and more than half met the recommended guideline for recreational sedentary screen time (58%), as displayed in Table 4.10. Additionally, approximately half of the cluster's members were males (56%) and were enrolled in the 10^{th} grade (54%).

The smallest group was Cluster No.5, accounting for 13.7% (74) of the students, same that was labeled as "3 mLRBs-T", indicating three predominant mLRBs (i.e., 2 traditional and 1 emergent). All students in this cluster did not meet the recommended levels of physical activity (100%) and at least 3 dietary behaviors (100%), as well as over half of them had increased recreational sedentary screen time (65%). The members of this "3 mLRBs-T" cluster adhered to 3 key behavioral recommendations; they did not smoke (100%), did not consume alcohol (100%), and met the recommended sleep time of 8 hours or more per night (100%), as shown in

Table 4.10. Additionally, this group consisted of approximately half females (53%) and more members were 10th graders (58%).

Table 4.10. Clusters characteristics in terms of 6 mLRBs among a local sample of Hispanic/Latino American adolescents, based on the newly imputed dataset (N = 539).

MI#6 Cluster #:	2	3	5	1	4
At Risk:	2 mLRBs	3 mLRBs-E	3 mLRBs-T	4 mLRBs	6 mLRBs
Size:	18.6% (n=100)	15.0% (n=81)	13.7% (n=74)	27.3% (n=147)	25.4% (n=137)
Inputs (importance)					
Diet (1.00)	No (100%)	At risk (100%)	At risk (100%)	At risk (100%)	At risk (90.5%)
TOB (0.81)	No (91.0%)	No (100%)	No (100%)	No (100%)	At risk (82.5%)
OH (0.78)	No (99.0%)	No (100%)	No (100%)	No (100%)	At risk (75.2%)
PA (0.62)	At risk (55.0%)	No (100%)	At risk (100%)	At risk (100%)	At risk (72.3%)
ST (0.46)	At risk (57.0%)	At risk (58.0%)	No (100%)	At risk (100%)	At risk (69.3%)
RSST (0.05)	No (58.0%)	At risk (56.8%)	At risk (64.9%)	At risk (67.3%)	At risk (75.2%)

Cluster No.3 was identified as "3 mLRBs-E, comprising 15.0% (81) of the students and exhibiting predominantly 3 mLRBs. Within this cluster, involving 1 traditional and 2 emergent risk behaviors, more than half of the students did not meet the recommended sleep time (58%), had increased recreational sedentary screen time (57%), and none of them met the 3 or more dietary behaviors (100%), as presented in Table 4.10. Similarly, the "3 mLRBs-E" cluster was still considered moderately healthy as all adolescents adhered to three 3 key behavioral recommendations. Specifically, none of its members smoke (100%), none consume alcohol (100%) and all complied with the recommended physical activity of 60 minutes a day (100%). Additionally, this cluster primarily consisted of males (65%), and half of the members were students enrolled in the 9th grade (51%).

The largest group was Cluster No.1, accounting for 27.3% (147) of the adolescents, was labeled as "4 mLRBs" as it exhibited the 2 traditional and 2 emergent risk behaviors. Within this cluster, all of its members did not meet recommendations for physical activity (100%), at least

three or more dietary behaviors (100%), and sleep time (100%), as well as more than half of the cluster exhibited increased recreational sedentary screen time (67%). Even though all adolescents within this cluster did not smoke (100%) or did drink alcohol (100%), the "4 mLRBs" cluster had a predominance of 4 out of the 6 mLRBs, as shown in Table 4.10, marked as at-risk behaviors. Additionally, the group was comprised of a majority of females (57%) and more than half were 10^{th} grade students (54%).

Lastly, Cluster No.4 was labeled as “6 mLRBs,” comprising 25.4% (137) of the local sample of adolescents. This cluster was characterized by adolescents that did not meet most of the behavioral recommendations. Within this group, most of these adolescents met less than three dietary behaviors (91%), engage in smoking (83%) and consume alcohol (75%), as exhibited in Table 4.10. As well, many of the students in this cluster did not meet the recommended sleep time (69%) and the majority had increased recreational sedentary screen time (75%). Additionally, cluster “6 mLRBs” was characterized by approximately half males (53%) and also more than half were 10^{th} grade students (61%).

Additionally, several attempts were made to perform on the imputed dataset the Two-Step Cluster Analysis with stratification by sex, using the same input order and conditions. However, like the results obtained with the original data, the clustering results for the imputed data were found to be unstable. This suggests the need for an advanced analysis approach to gain a clearer understanding of the clustering patterns when stratified by sex.

4.5.3. Cluster Differences in terms of Cross-Sectional Outcomes

After performing Two-Step Cluster analysis in SPSS, comparisons were made between the clusters using the cross-sectional outcome variable body weight status classification for overweight and obese (OV and OB), as well as symptom of depression and school performance.

The cross-sectional outcome cluster comparisons were conducted for the TSC results obtained using the original data, as well as for the TSC results obtained from the imputed data separately, as shown in Tables 4.11 and 4.12. When comparing the clusters based on cross-sectional outcomes, a difference can be observed when analyzing the original and the imputed datasets. Students who were classified in the cluster with the highest number of mLRBs, compared to those who were classified in the cluster with the lowest number of mLRBs, showed a higher likelihood of self-reporting adverse health-, mental-, and school-related outcomes.

Table 4.11. Observed cluster differences in terms of cross-sectional outcomes among Hispanic/Latino American adolescents in 2019, based on original dataset (N = 454).

Cluster #:	**3**	**2**	**1**	**5**	**4**
At Risk:	**2 mLRBs**	**3 mLRBs-E**	**3 mLRBs-T**	**4 mLRBs**	**6 mLRBs**
Size:	**19.8%** (n=90)	**15.4%** (n=70)	**13.0%** (n=59)	**28.4%** (n=129)	**23.3%** (n=106)
Cross-Sectional Outcomes, % (95% CI) & cell size					
Weight Status:					
Students with BMIs ≥85th and <95th pctl. (Overweight)	12.2 (6.3 – 20.8) 11	8.6 (3.2 – 17.7) 6	18.6 (9.7 – 30.9) 11	19.4 (13.0 – 27.3) 25	19.8 (12.7 – 28.7) 21
Students with BMIs ≥95th percentile (Obese)	18.9 (11.4 – 28.5) 17	15.7 (8.1 – 26.4) 11	18.6 (9.7 – 30.9) 11	13.2 (7.9 – 20.3) 17	9.4 (4.6 – 16.7) 10
Depression Symptom:					
Students felt sad or hopeless for 2 weeks or more in the past year*	33.7 (24.0 – 44.5) 30	18.8 (10.4 – 30.1) 13	30.5 (19.2 – 43.9) 18	44.2 (35.5 – 53.2) 57	55.7 (45.7 – 65.3) 59
School Performance:					
Students with mostly Cs or lower grades during the past 12 months*	15.9 (9.0 – 25.2) 14	11.8 (5.2 – 21.9) 8	12.7 (5.3 – 24.5) 7	21.5 (14.5 – 29.9) 26	32.3 (23.3 – 42.5) 32

*Statistically significant differences in proportions between the TSC clusters based on the Pearson chi-square test ($p<0.05$).

For instance in Table 4.11, it was observed that among Hispanic/Latino adolescents, those categorized in the "6 mLRBs" cluster (all six at-risk behaviors) were more likely to be overweight (19.8% vs. 12.2%), self-reported symptom of depression (55.7% vs. 33.7%) and had

lower school performance (32.3% vs. 15.9%) compared to students in the "2 mLRBs" cluster (PA and ST as at-risk behaviors) in the original dataset (n=454).

Table 4.12. Observed Cluster Differences in terms of Cross-Sectional Outcomes Among Hispanic/Latino American Adolescents, Based on the imputed Dataset (N = 539).

MI#6 Cluster #:	2	3	5	1	4
At Risk:	**2 mLRBs**	**3 mLRBs-E**	**3 mLRBs-T**	**4 mLRBs**	**6 mLRBs**
Size:	**18.6%** (n=100)	**15.0%** (n=81)	**13.7%** (n=74)	**27.3%** (n=147)	**25.4%** (n=137)
Cross-Sectional Outcomes, % (95% CI) & cell size					
Weight Status:					
Students with BMIs ≥85th and <95th pctl. (Overweight)	13.0 (7.1 – 21.2) 13	11.1 (5.2 – 20.0) 9	14.9 (7.7 – 25.0) 11	17.7 (11.9 – 24.8) 26	18.2 (12.2 – 25.7) 25
Students with BMIs ≥95th percentile (Obese)	20.0 (12.7 – 29.2) 20	14.8 (7.9 – 24.4) 12	21.6 (12.9 – 32.7) 16	16.3 (10.7 – 23.3) 24	10.2 (5.7 – 16.6) 14
Depression Symptom:					
Students felt sad or hopeless for 2 weeks or more in the past year*	34.0 (24.8 – 44.2) 34	25.9 (16.8 – 36.9) 21	31.1 (20.8 – 42.9) 23	45.6 (37.4 – 54.0) 67	54.7 (46.0 – 63.3) 75
School Performance:					
Students with mostly Cs or lower grades during the past 12 months*	17.0 (10.2 – 25.8) 17	12.3 (6.1 – 21.5) 10	14.9 (7.7 – 25.0) 11	22.4 (16.0 – 30.1) 33	29.2 (21.7 – 37.6) 40

*Statistically significant differences in proportions between the TSC clusters based on the Pearson chi-square test ($p<0.05$).

Similarly, it was observed in the imputed dataset, students who were classified in a cluster with a higher number of mLRBs, compared to those who were classified in a cluster with a lower number of mLRBs, showed a higher likelihood of self-reporting undesirable health-, mental-, and school-related outcomes when observing 3 out the 4 outcomes. For example, in Table 4.12, among Hispanic/Latino adolescents, those categorized in the "4 mLRBs" cluster (PA, Diet, RSST, and ST as at-risk behaviors) were more likely to be overweight (17.7% vs. 11.1%), had self-reported symptom of depression (45.6% vs. 25.9%) and had lower school performance (22.4% vs. 12.3%) compared to students in the "3 mLRBs-E" cluster (Diet, RSST, and ST as at-risk behaviors) in the imputed dataset (N=539).

4.6. Aim 5: Traditional and Emergent Health Risk Indices for Adolescents Predicting Cross-Sectional Outcomes & Prevailing Lifestyle Patterns among a Local Sample

Specific Aim 5 focuses on two main objectives based on the imputed dataset. First, it aimed at identifying the most frequently occurring combinations or lifestyle patterns of mLRBs among a local sample of Hispanic/Latino American adolescents attending high school in a community located in the U.S.-Mexico border region. Second, it aimed at exploring whether the inclusion of the two emerging mLRBs (RSST and ST) alongside the four traditional mLRBs provides relevant information regarding a health risk index for adolescents.

Table 4.13 Summary of index scoring method for mLRBs based on recommendations for adolescents and overall percentage of the local Hispanic/Latino students that engaged in each individual risk behavior, based the imputed dataset (n = 539).

	Modifiable Lifestyle Risk Behaviors Scoring Method: 1 = At Risk, 0 = Not at Risk.	**Percentage "At Risk"**
Traditional mLRBs		
PA (Physical Activity)	**1** = have not engaged in at least 60 minutes per day on physical activity during the past 7 days prior to the survey	69.6%
Diet (Dietary Behavior)	**1** = have not meet at least 3 out of the 5 food-related items as recommended by the CDC within the prior week (including fruit, vegetables, soda, milk, and breakfast)	79.0%
TOB (Tobacco Use)	**1** = have use any tobacco product at least on one day during the 30 days prior to the survey (including cigarettes, electronic vapor products, or smoked or flavored tobacco in hookah)	22.6%
OH (Alcohol Consumption)	**1** = consuming alcohol beverages at least a glass of alcohol during the past 30 days prior to the survey	19.3%
Emerging mLRBs		
RSST (Recreational Sedentary Screen Time)	**1** = have spent 3 or more hours a day on recreational sedentary screen time on an average school day (including TVs, computers, videogames, smartphones, iPads, or tablets)	62.7%
ST (Sleep Time)	**1** = have sleep for less than 8 hours on an average school night	64.2%

*At Risk corresponds to not adhering to the recommendations for adolescents for each individual behavior

The scoring of the adolescent health risk index was calculated based on the sum of individuals' engagement with any of the traditional and emerging mLRBs, where behaviors are coded as 1 = At Risk and 0 = Not at Risk (Table 4.13). Using multiple logistic regression model approach and controlling for sex and school grade, it was assessed the relevance of an adolescent health risk index in predicting cross-sectional intermediate health outcomes, including body weight status, symptom of depression, and school performance, by building a basic traditional model and comparing it to three emergent models, each incorporating RRST, ST, or both behaviors. The original and imputed data yielded similar results, and the findings from imputed dataset are presented below.

Table 4.13 provides the description of the index scoring method for each mLRBs. The scoring method is based on the recommendations specifically for adolescents supported by the CDC. The behaviors labeled as "At Risk" indicate the overall percentages of students in the local imputed dataset Hispanic/Latino adolescent sample who did not follow the recommendations. Overall, the findings indicate that nearly 70% of the sample did not comply with the physical activity recommendation, 79% did not meet the diet recommendation, 23% engaged in tobacco use, 19% consumed alcohol, 63% had an increased recreational sedentary screen time, and 64% did not meet the recommended sleep time.

Regarding the distribution of cross-sectional outcomes by each individual mLRB, it was observed that students whose BMI-for-age was equal to or above the 85^{th} percentile had a higher prevalence insufficient PA, TOB use, increased RSST and short ST. On the contrary, students whose BMI-for-age was below the 85^{th} percentile had a higher prevalence of engaging in unhealthy DIET, and OH consumption, as shown in Table 4.14. Additionally, it was observed that students who reported the presence of a symptom for depression or low school performance

had a higher prevalence of engaging in all six mLRBs (PA, Diet, TOB, OH, RSST, and ST) compared to their peers who did not report these outcomes, as displayed in Table 4.14.

Table 4.14. Characteristics and cross-sectional outcomes distribution by each individual mLRB in the local sample of Hispanic/Latino adolescents, imputed dataset (n = 539).

Variable & Levels	n	Modifiable Lifestyle Risk Behaviors (mLRBs)					
		Traditional				Emergent	
		PA (%)	Diet (%)	TOB (%)	OH (%)	RSST (%)	ST (%)
Characteristics							
Sex:							
Male	280	60.4	78.6	24.6	18.2	62.9	60.4
Female	259	79.5	79.5	20.5	20.5	62.5	68.3
School Grade:							
9th grade	238	66.8	79.8	20.2	16.0	63.4	64.7
10th grade	301	71.8	78.4	24.6	21.9	62.1	63.8
Cross-Sectional Outcomes							
Weight Status:							
BMI <85th	369	67.8	79.1	21.7	22.0	62.3	61.8
BMI ≥85th	170	73.5	78.8	24.7	12.5	63.5	69.4
Depression Symptom:							
Not reported	319	64.6	77.7	16.6	13.2	61.1	56.4
Sad or hopeless	220	76.8	80.9	31.4	28.2	65.0	75.5
School Performance:							
Mostly As or Bs	428	69.4	78.3	19.6	17.8	62.6	62.1
Mostly Cs or lower	111	70.3	82.0	34.2	25.2	63.1	72.1
Total	539	69.6	79.0	22.6	19.3	62.7	64.2

Footnote: CDC's recommendations: Physical Activity (PA) 60 minutes or more every day; Recreational Sedentary Screen Time (RSST) 2 hours or less each day, and Sleep Time (ST) 8 hours or more per night.

Based on the potential scores (range 0-4) of Traditional mLRBs index, which includes the four key risk factors (PA, Diet, TOB, and OH), it was observed that 8% of the students reported not engaging in any "at-risk" behaviors, 26% engaged in one traditional mLRB, 45% engaged in two traditional mLRBs, 13% engaged in three traditional mLRBs, and 9% engaged in all four traditional mLRBs.

After incorporating the Traditional mLRBs and creating the 4-item index (PA, Diet, TOB, and OH), the distribution of the two emerging mLRBs in relation to this created Traditional mLRBs Index was examined, as shown in Table 4.15. Based on the Tradition

mLRBs Index score, which range from 0 to 4 score point, it was observed and became evident that as the number of traditional mLRBs engaged by adolescents increases, the likelihood of occurrence of both RSST and ST emerging mLRBs also increases (Table 4.15).

Table 4.15. Distribution of the Emerging mLRBs Based on the Scores of the Traditional mLRBs Index (N =539).

Score on the Traditional mLRBs Index	n	Emerging mLRBs	
		RSST % (n)	ST % (n)
0	39	46.2 (18)	51.3 (20)
1	140	47.7 (67)	59.3 (83)
2	240	67.5 (162)	65.8 (158)
3	73	75.3 (55)	64.4 (47)
4	47	76.6 (36)	80.9 (38)

Furthermore, after incorporating the Traditional and Emergent mLRBs as a 6-item index (including the former traditional mLRBs along with RSST and ST), it was found that 89% of the local sample engaged in at least two out of the six evaluated mLRBs. Only 2% of the adolescents were identified as not engaging in any "at-risk" behaviors. Additionally, 9% engaged in one "at-risk" behavior, and 20%, 29%, 25%, 10%, and 5% respectively reported engagement in two, three, four, five, and six "at-risk" behaviors from the new Traditional & Emergent mLRBs Index, as shown in Table 4.16.

Based on the Traditional and Emergent mLRBs index, which ranges from 0 to 6, an exploration of the distribution of the cross-sectional outcomes across this new index revealed interesting findings. Among the local sample of Hispanic/Latino American adolescents, it was observed that higher index scores of mLRBs were more prevalent among females (3 to 6 mLRBs) and those in the 10th grade (3, 5 and 6 mLRBs). Additionally, students whose BMI-for-age was equal to or above the 85th percentile had a higher prevalence of engaging in 3 to 5 mLRBs. On the contrary, students whose BMI-for-age was below the 85th percentile had a higher

prevalence of engaging in 0 to 2, and 6 mLRBs. Moreover, it was observed that students who reported the presence of a symptom for depression or low school performance had a higher prevalence of engaging in 4 to 6 mLRBs compared to their peers who did not report these outcomes and had higher prevalence of engaging with 0 to 3 mLRBs, as observed in Table 4.16.

Table 4.16. Estimated prevalence of Hispanic/Latino American Adolescents Meeting Zero to all Six Modifiable Lifestyle Risk Behaviors (mLRBs) based on the imputed Dataset (N = 539).

Variable & Levels	n	Traditional and Emergent mLRBs Index						
		0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)
Total	539	2.0	9.1	19.5	28.8	25.4	9.8	5.4
Sex:								
Male	280	3.2	10.7	21.1	26.8	24.3	8.9	5.0
Female	259	0.8	7.3	17.8	30.9	26.6	10.8	5.8
School Grade:								
9th grade	238	2.5	10.5	20.2	25.6	27.7	8.4	5.0
10th grade	301	1.7	8.0	18.9	31.2	23.6	11.0	5.6
Cross-Sectional Outcomes								
Weight Status:								
BMI <85th	369	2.7	9.2	20.3	27.4	24.9	9.8	5.7
BMI ≥85th	170	0.7	8.8	17.6	31.8	26.5	10.0	4.7
Depression Symptom:								
Not reported	319	3.1	12.5	21.6	28.8	24.5	6.9	2.5
Sad or hopeless	220	0.5	4.1	16.4	28.6	26.8	14.1	9.5
School Performance:								
Mostly As or Bs	428	2.1	9.1	20.6	31.1	24.1	8.4	4.7
Mostly Cs or lower	111	1.8	9.0	15.3	19.8	30.6	15.3	8.1

4.6.1. Prediction of Cross-sectional Outcomes

The inclusion of the two emergent mLRBs into the traditional mLRB index did not improve the prediction of the cross-sectional outcome of weight status. As shown in Table 4.17, the lack of significant changes was observed in all four mLRBs models (Traditional, Traditional + RSST, Traditional + ST, Traditional & Emergent). The Traditional model (68.5% prediction; p= 0.554) and the final emergent model (68.5% prediction; p= 0.691) exhibited the same

predictive capabilities. None of the 4 models were statistically significant. When the sample was stratified by sex and both models were applied separately, the emergent mLRB model showed significant prediction of weight status only among females in the original data (70.9%, p = 0.035). However, there were no significant differences between the models in classifying this outcome when analyzing the imputed data. All four mLRBs models (Traditional, Traditional + RSST, Traditional + ST, Traditional & Emergent) have the same percentage of prediction, which is 68.5%. This indicates that adding the RSST and ST mLRBs to the traditional model did not improve the prediction for weight status.

Table 4.17. Estimated percentage of prediction for cross-sectional outcomes based on the logistic regression models adding to the two emergent to the traditional mLRBs.

Cross-Sectional Outcomes:	mLRBs Models, % of Prediction			
	Traditional	Traditional + RSST	Traditional + ST	Traditional & Emergent
Weight Status	68.5	68.5	68.5	68.5
Symptom of Depression	67.2*	68.1*	69.0*	69.2*
School Performance	79.4*	79.4*	79.4*	79.4*

*Models were statistically different using multiple logistic regression analysis (p <0.001)

Similarly, the Traditional mLRBs model achieves a prediction percentage of 79.4% (p<0.001). The addition of RSST, ST, or both emergent mLRBs does not result in any improvement in prediction. Therefore, the emergent mLRBs did not enhance the classification of school performance in this context. On the contrary, incorporating the emergent mLRBs into the traditional index improved the prediction by 2% for the cross-sectional outcome of a symptom of depression, as shown in Table 4.17. The Traditional mLRBs model has a prediction percentage of 67.2% (p<0.001), while the models with the inclusion of RSST, ST, and both emergent mLRBs show slight improvements in prediction percentages 68.1%, 69.0%, and 69.2% with

$p<0.001$ respectively. This suggests that incorporating the emergent mLRBs, particularly RSST and ST, enhances the prediction of the symptom of depression.

4.6.2. Unique Patterns Involving Traditional and Emergent mLRBs

For this second part of the analysis when calculating the unique patterns involving the 4 traditional and the two emergent mLRBs for NCDs, all possible arrangements were considered using the 6 mLRBs without repetition of behaviors in the combinations. Each mLRB was represented by a binary digit, where "1" indicated the presence of an "at risk" behavior, and "0" indicated the absence of an "at risk" behavior. Based on the potential student's engagement with any of the 6 mLRBs, there were a total of 2 raised to the power of 6 (2^6) possible combinations. However, it is important to note that one combination corresponds to all 6 risk factors being absent, represented by all zeros. Thus, by including this absence of mLRBs combination, the total number of calculated combinations was $2^6 + 1$, resulting in 65 possible unique non-repeating patterns or combinations.

Table 4.18 portrays 51 out of the 65 unique patterns of mLRBs that were observed within the local sample (N =539), with 14 combinations being absent. Among those adolescents engaging with only one risk behavior, the most common individual mLRBs were insufficient physical inactivity (2.4%) and unhealthy dietary behaviors (2.4%). This was followed by reduced sleep time (1.9%), increased recreational sedentary screen time (1.5%), tobacco use (0.7%), and alcohol consumption (1.2%). Among those students engaging with two risk behaviors, the four most common combinations of mLRBs were insufficient PA + unhealthy Diet (4.8%); unhealthy Diet + reduced ST (4.1%); unhealthy Diet + increased RSST (3.9%); and insufficient PA +reduced ST (3.3%).

Table 4.18. Prevalence of the mLRBs combinations among a local Sample of Hispanic/Latino Adolescents (N = 539).

Combinations of Modifiable Lifestyle Risk Behaviors (mLRBs)										
ID	mLRBs Score	Traditional				Emergent		Freq	Percent	Cumulative %
		PA	Diet	TOB	OH	RSST	ST			
1	4	1	1	0	0	1	1	99	18.37	18.37
2	3	1	1	0	0	1	0	48	8.91	27.31
3	3	1	1	0	0	0	1	48	8.91	36.21
4	6	1	1	1	1	1	1	29	5.38	41.59
5	2	1	1	0	0	0	0	26	4.82	46.41
6	3	0	1	0	0	1	1	25	4.64	51.05
7	2	0	1	0	0	0	1	22	4.08	55.13
8	2	0	1	0	0	1	0	21	3.90	59.03
9	2	1	0	0	0	0	1	18	3.34	62.37
10	3	1	0	0	0	1	1	16	2.97	65.34
11	5	1	1	1	0	1	1	15	2.78	68.12
12	1	1	0	0	0	0	0	13	2.41	70.53
13	1	0	1	0	0	0	0	13	2.41	72.95
14	5	0	1	1	1	1	1	11	2.04	74.99
15	0	0	0	0	0	0	0	11	2.04	77.03
16	2	0	0	0	0	1	1	10	1.86	78.88
17	1	0	0	0	0	0	1	10	1.86	80.74
18	5	1	1	1	1	0	1	9	1.67	82.41
19	4	1	1	1	0	1	0	9	1.67	84.08
20	1	0	0	0	0	1	0	8	1.48	85.56
21	5	1	1	1	1	1	0	7	1.30	86.86
22	5	1	1	0	1	1	1	6	1.11	87.97
23	5	1	0	1	1	1	1	5	0.93	88.90
24	4	1	1	0	1	1	0	4	0.74	89.64
25	4	0	1	1	1	1	0	4	0.74	90.39
26	4	0	1	1	1	0	1	4	0.74	91.13
27	2	1	0	0	0	1	0	4	0.74	91.87
28	1	0	0	1	0	0	0	4	0.74	92.61
29	4	1	1	0	1	0	1	3	0.56	93.17
30	4	1	1	1	0	0	1	3	0.56	93.72
31	4	0	1	1	0	1	1	3	0.56	94.28
32	3	1	1	0	1	0	0	3	0.56	94.84
33	3	0	1	0	1	1	0	3	0.56	95.39
34	4	1	1	1	1	0	0	2	0.37	95.77
35	4	1	0	1	0	1	1	2	0.37	96.14
36	4	0	1	0	1	1	1	2	0.37	96.51
37	3	1	1	1	0	0	0	2	0.37	96.88
38	3	1	0	1	0	1	0	2	0.37	97.25
39	3	0	1	1	1	0	0	2	0.37	97.62
40	3	0	0	1	1	0	1	2	0.37	97.99
41	4	1	0	1	1	1	0	1	0.19	98.18
42	4	0	0	1	1	1	1	1	0.19	98.36
43	3	1	0	1	1	0	0	1	0.19	98.55
44	3	0	1	1	0	1	0	1	0.19	98.73
45	3	0	1	0	1	0	1	1	0.19	98.92
46	3	0	0	1	1	1	0	1	0.19	99.11
47	2	0	1	1	0	0	0	1	0.19	99.29
48	2	0	0	1	0	0	1	1	0.19	99.48
49	2	0	0	0	1	1	0	1	0.19	99.66
50	2	0	0	0	1	0	1	1	0.19	99.85
51	1	0	0	0	1	0	0	1	0.19	100.00

* ”0” denotes the absence of engagement, and ”1” denotes the occurrence of the mLRBs.

Moreover, among those adolescents engaged with three risk behaviors, the most common combinations of mLRBs were insufficient PA + unhealthy Diet + increased RSST (8.9%) and insufficient PA + unhealthy Diet + reduced ST (8.9%). This was followed by unhealthy Diet + increased RSST+ reduced ST (4.6%) and insufficient PA + increased RSST+ reduced ST (3.0%). Among those students engaged with four risk behaviors, the most frequent combination of mLRBs among the local sample was insufficient PA + unhealthy Diet + increased RSST +reduced ST (18.37%). Finally, among those adolescents engaged with five risk behaviors, the most common combination of mLRBs was insufficient PA + unhealthy Diet + TOB use + increased RSST + reduced ST (2.8%), as exhibited in Table 4.18.

Notably, the 25 most commonly occurring combinations accounted for 90% of all adolescents in the local sample. The prevailing unique pattern of mLRBs was the presence of 4 mLRBs (insufficient PA + unhealthy Diet + increased RSST + reduced ST), which had a prevalence of 18.4%, followed by two combinations of 3 mLRBs (insufficient PA + unhealthy Diet + increased RSST and insufficient PA + unhealthy Diet + reduced ST) both with a prevalence of 8.9% (Table 4.18). Additionally, with a frequency of 5.4% was the occurrence of all 6 mLRBs together and was ranked in the 4th place, while 2.0% was the occurrence of the absence of all the mLRBs and was ranked in the 15th place.

Among female adolescents, the prevalence of unique combinations of mLRBs revealed that the 21 most commonly occurring combinations accounted for 90.4% of all females in the local sample (n = 259), tables not shown here. In addition, only the top 5 most frequent combinations accounted for more than half of the females (53.3%). The most prevalent unique pattern was the combination of 4 mLRBs (insufficient PA + unhealthy Diet + increased RSST + reduced ST), which was observed in 22% of females. This was followed by two combinations of

3 mLRBs (insufficient PA + unhealthy Diet + reduced ST and insufficient PA + unhealthy Diet + increased RSST) with prevalence of 10.4% and 8.9% respectively. The occurrence among females of all 6 mLRBs together was found in 5th place, with a frequency of 5.8%, while less than 1% of females did not engage in any of the 6 mLRBs and was ranked in the 30th place.

When examining the prevalence of unique combinations of mLRBs among male adolescents, it was found that the 24 most commonly occurring combinations accounted for 90.0% of all males (n = 280) in the local sample. Additionally, the 7 most frequent combinations accounted for more than half of the males (52.5%), please note that tables detailing these combinations are not included in this document. The most prevalent unique pattern observed among male adolescents, as was with the female adolescents' group, was the presence of 4 mLRBs (insufficient PA + unhealthy Diet + increased RSST + reduced ST), occurring in 15% of the males. This was followed by three combinations of 3 mLRBs: insufficient PA + unhealthy Diet + increased RSST with a prevalence of 8.9%, insufficient PA + unhealthy Diet + reduced ST with a prevalence of 7.5%, and insufficient PA + increased RSST + reduced ST with a prevalence of 5.71%. The occurrence among males of all 6 mLRBs together was found in 6th place, with a frequency of 5.0%, while 3.2% of males were not involved in any of the 6 mLRBs, and this combination was ranked in 9th place.

CHAPTER 5: DISCUSSION

5.1. Brief Summary of the Study Rationale

Described as the "invisible epidemic," NCDs are the leading causes of death and disability in low-, middle-, and high-income countries (Piovani et al., 2022). Given that nowadays people live longer, and at the same time, the long-term burden of NCDs continues to increase, global and national health agendas are prioritizing this public health concern (Hambleton et al., 2023; Heller et al., 2019; Watkins et al., 2019). Rather than focusing on the treatment of chronic diseases, a new direction is to focus on the prevention of NCDs specially at an early stage when adolescents are exposed and are vulnerable for engaging in behaviors that are lifetime determinants of health (Akseer et al., 2020; Bundy et al., 2018; Jain et al., 2022; Ni et al., 2023; Patton et al., 2016; Watkins et al., 2019). Research has shown that the four most prevalent types of NCDs, cardiovascular diseases (i.e., heart attacks and stroke), diabetes, chronic respiratory diseases (e.g., chronic obstructive pulmonary disease and asthma), and cancers, can be preventable. These NCDs are largely driven by four common unhealthy behaviors including tobacco use, harmful use of alcohol, unhealthy diets, and physical inactivity also known or recognized as traditional (Schwartz et al., 2021) modifiable lifestyle risk behaviors (mLRBs).

Modifiable risk factors related to NCDs are often studied individually in spite of individuals being susceptible to engage simultaneously in multiple lifestyle behaviors, which consequently raises their risk for the onset and progression of NCDs (Caldeira et al., 2023; Pengpid & Peltzer, 2019; Peters et al., 2019). Furthermore, recent evidence has been accumulating on other mLRBs such as increased sedentary behaviors (Chaput et al., 2020; Katzmarzyk et al., 2019; Poses-Ferrer et al., 2022; Tremblay et al., 2016) and insufficient sleep

time (Chattu et al., 2018; Hafner et al., 2017; Itani et al., 2017; Machado et al., 2023), also known as emerging mLRBs and associated to NCDs.

In the context of the border city of El Paso, Texas most of its population is Hispanic (82%) and is characterized for having a high prevalence NCDs including those counted among the top 10 causes of death in the country (Buscemi et al., 2021). This study assesses mLRBs associated with NCDs among adolescents attending high school. This secondary data analysis utilized cross-sectional data collected by UTEP's researchers through the 2019 El Paso YHBS which was modeled after the CDC Youth Risk Behavior Surveillance System (YRBSS). The main goal of this project was to evaluate the prevalence of traditional (physical activity, dietary behaviors, tobacco use, and alcohol consumption), and emerging (recreational sedentary screen time, and sleep time) mLRBs for NCDs among a local sample of in-school Hispanic/Latino adolescents living along the U.S.-Mexico border region in El Paso County, TX.

This study focused on Hispanic/Latino in-school adolescents (n=539) and examined both traditional and emerging risk behaviors for NCDs. By utilizing a cross-sectional design and local survey data, the researchers were able to gather information regarding several health risk behaviors among adolescents in the target community. This type of research is valuable for understanding the prevailing traits of traditional and emerging mLRBs for NCDs and its potential impacts among certain populations, specifically Hispanic/Latino adolescents in the U.S.-Mexico border region.

Assessing mLRBs is crucial for identifying potential areas for developing targeted health promotion programs as well as early intervention programs. By examining both traditional and emerging mLRBs among adolescents, this study provides a comprehensive overview of the factors that may contribute to the development of NCDs that could be manifested during

adulthood. It is important to note that the study is based on self-reported data from an observational cross-sectional study, which introduces certain limitations such as nonresponse bias, recall bias, social desirability bias among other weaknesses. However, by using a standardized survey tool like the CDC YRBSS, the researchers aimed to mitigate these biases and ensure comparability with other studies that also used standardized CDC YRBSS surveys.

5.2. Summary of Major Finding

Overall, our local sample of Hispanic/Latino adolescents consisted of 52% male and 48% female participants; 44% of the participants were enrolled in the 9th grade and 56% of the participants were in 10th grade. Most of them (95%) reported speaking English well or very well, and many (64%) reported speaking another language at home about half of the time or more, as well as several (58%) reported being second-generation Hispanic. The results of this secondary data analysis indicated that many Hispanic/Latino adolescents did not meet the recommended CDC guidelines for mLRBs.

Considering traditional mLRBs for NCDs, the following observations were made: 70% of students did not engage in at least 60 minutes of physical activity daily for seven days (PA), 79% did not meet at least three out of the five dietary recommendations (i.e., fruit, vegetables, milk, breakfast, and soda) in the past week (DIET), 23% reported using tobacco products in the past 30 days (TOB), and 17% consumed at least one alcoholic beverage in the past 30 days (OH). Moreover, considering emerging mLRBs for NCDs: 63% spent three or more hours engaging in recreational sedentary screen time on an average school day for non-school purposes (RSST), and 64% had seven or fewer hours of sleep time on an average school night (ST).

When stratifying the original dataset by sex, it was found that when compared to their male counterparts, Hispanic/Latino female adolescents exhibited a higher prevalence on 5

individually measured behaviors (Pearson chi-square test, $p<0.05$). Specifically, these included physical inactivity, not getting physical education, low milk consumption, not eating breakfast, and short sleep time. On the contrary, Hispanic/Latino male adolescents showed a significative higher prevalence only regarding soda consumption compared to their female peers (Pearson chi-square test, $p<0.05$).

When stratifying the original dataset by school grade, it was observed that 10th grade students showed a higher prevalence in 3 individually measured behaviors when compared to their peers in 9th grade (Pearson chi-square test, $p<0.05$). Specifically, not getting physical education, not eating breakfast, and drinking alcohol. When analyzing based on body weight status, it was observed that students identified with no excess body weight showed a higher prevalence on soda consumption only compared to students with excess body weight (Pearson chi-square test, $p<0.05$).

When comparing our findings to those reported in the 2019 CDC YRBSS data at the state and national levels, it was observed that most local students did not meet the recommended CDC guidelines showing a similar trend reported for their state and national counterparts. Nonetheless, among 9th grade Hispanic/Latino adolescents, local students showed lower percentages for insufficient physical activity (67% versus 82% in TX and 76% in US), insufficient physical education (42% versus 58% in US), not drinking milk (19% versus 31% in TX and 28% in US), no breakfast intake (55% versus 72% in TX and 66% in US), and insufficient sleep time (65% versus 72% in TX and 71% in US). Additionally, 9th grade students from our local sample had a lower soda (68% versus 75% in US) and alcohol consumption (13% versus 18% in TX and 19% in US) when compared to state and national averages, respectively (one-sided Binomial-Test, $p<0.05$).

Similarly, among 10th grade Hispanic/Latino adolescents, local students showed lower percentages for insufficient physical activity (72% versus 77% in TX and 79% in US), insufficient physical education (58% versus 68% in TX and 72% in US), no milk consumption (21% versus 31% in TX and 28% in US), and insufficient sleep time (64% versus 78% in TX and 76% in US). Additionally, similar to 9th grade students, 10th grade students reported lower soda intake (66% versus 76% in TX and 72% in US) and drinking less alcohol (21% versus 26% in TX and 29% in US) when compared to the state and national averages (one-sided Binomial-Test, $p<0.05$).

Conversely, a higher percentage of local 9th grade students that did not consume any vegetables (17% versus 11% in TX and 10% in US) and fruits (10% versus 5% in US) when compared to the state and national data, respectively (one-sided Binomial-Test, $p<0.05$). Also, both local 9th grade (20% versus 12% in TX and 29% in US) and 10th grade students (25% versus 15% in TX and 34% in US) were more likely to use TOB products that their state peers, but less frequently than their national counterparts (one-sided Binomial-Test, $p<0.05$).

Rather than examining each behavior individually, many countries have introduced the 24-hour movement behaviors (24-MBs) guidelines due to their implications on health. This combined behavior concept is comprised of three lifestyle health behaviors, including sleep, physical activity, and sedentary behaviors (Rollo et al., 2020). An average of 30% of our local sample (N=531) complied with each individual recommendation of the 24-MBs guidelines: 30.4% met physical activity, 37.4% met recreational sedentary screen time, and 35.8% met sleep time. Overall, only 5.8% of the participants met the three combined 24-h MBs guidelines for all three evidence-based movement behaviors. Meanwhile, 23.0% of the participants met two combined recommendations, 39.5% met only one recommendation, and 31.5% did not meet any

of them. Additionally, in the prevalence of meeting all three 24-MBs when the sample was stratified by sex, there was a statistically significant difference between males (8.7%, 95% CI 5.37 – 12.03) and females (2.7%, 95% CI 0.71 – 4.68) (Pearson Chi-Square-Test (1, N=531) = 8.662, p= 0.003).

Furthermore, when comparing the overall 5.8% (95% CI, 4.0, 8.2) achieved by our local sample to the 4.0% (95% CI, 3.5, 4.4) reported for their national peers in meeting the three combined 24-h MBs guidelines (Knell et al., 2019), our local sample's compliance was significantly higher than the reported national value (One-Sample Binomial Test, p= 0.025). Moreover, when male counterparts were compared, local males had a significantly higher compliance rate of 8.7% (95% CI, 5.37 – 12.03) in meeting the 24-MBs guidelines, surpassing the national value for males, which was reported at 5.4% (95% CI, 4.7, 6.1) (One-Sample Binomial Test, p= 0.015). On the other hand, local females achieved a compliance rate of 2.7% (95% CI, 1.1, 5.6) in meeting the 24-MBs guidelines, which was not statistically significant different from the national female compliance rate of 2.5% (95%CI, 2.0, 3.0) (One-Sample Binomial Test, p= 0.458).

To identify adolescents based on the co-occurrence of traditional and emerging mLRBs associated with NCDs, a two-step cluster (TSC) analysis was performed on both the original dataset (n = 454) and on an imputed dataset (n = 539). The overall results from both datasets were consistent, and to incorporate all potential cases and minimize bias, the findings from imputed data (MI #6) are reported herein. The analysis revealed five well-defined clusters with a fair silhouette coefficient of 0.4, identified groups varying from relatively healthy to unhealthy. Among these clusters, the clusters were labeled depending on the number of mLRBs marked as at-risk. The cluster labeled as "2 mLRBs" exhibited the fewest behaviors marked as at-risk and

accounted for 18.6% (100) of the sample. This was followed by the "3 mLRBs-T" cluster comprising 13.7% (74) of the participants, “3 mLRBs-E” 15.0% (81), “4 mLRBs” 27.3% (147), and lastly “6 mLRBs” with all 6 behaviors marked as at-risk and comprising 25.4% (137) of the adolescents.

Furthermore, when comparing the identified clusters based on cross-sectional outcomes, it was observed that participants classified in the cluster with the highest number of at-risk behaviors (6 mLRBs) showed a higher likelihood of self-reporting adverse outcomes compared to those in the cluster with the lowest (2 mLRBs); specifically, overweight (18.2% versus 13.0%), symptom of depression (54.7% versus 34.0%), and low school performance (29.2% versus 17.0%). Similarly, when comparing the "4 mLRBs" cluster to the "3 mLRBs-E" cluster, it was observed that participants in the “4 mLRBs” cluster had a higher prevalence of overweight (17.7% versus 11.1%), obesity (16.3% versus 14.8%), symptom of depression (45.6% versus 25.9%), and low school performance (22.4% versus 12.3%).

Finally, to explore whether the inclusion of the two emerging mLRBs had an impact on the classification of cross-sectional outcomes, a traditional index score and an emergent index score were computed based on the students’ engagement with mLRBs for NCDs. Since the original and imputed data sets yielded similar results using multiple logistic regression analysis, controlling for sex and school grade, the findings from imputed data (MI #6) are reported herein. It was observed that students whose BMI-for-age was equal to or above the 85^{th} percentile had a higher prevalence of PA, TOB, RSST, ST. On the contrary, students whose BMI-for-age was below the 85^{th} percentile had a higher prevalence of engaging in OH and DIET. Moreover, it was observed that students who reported the presence of a symptom for depression or low school performance had a higher prevalence of engaging with any of the six individual mLRBs for

NCDs (PA, DIET, TOB, OH, RSST, and ST) compared to their peers who did not report these outcomes.

Based on the basic model, including the traditional mLRBs index (range 0-4), it was observed that 8% of the students reported not engaging in any "at-risk" behaviors, 26%, 45%, 13%, and 9% engaged in one, two, three, and all four traditional mLRB, respectively. Moreover, it was noted that as the number of traditional mLRBs engaged by students increases the occurrence of both emerging mLRBs (RSST and ST) also increase. Furthermore, after incorporating the traditional and emergent mLRBs index (range 0-6), it was observed that only 2% of the adolescents did not engage in any "at-risk" behaviors. Additionally, 9% engaged in one "at-risk" behavior, and 20%, 29%, 25%, 10%, 5% of adolescents reported engagement with two, three, four, five, and six "at-risk" behaviors respectively.

The inclusion of the two emerging mLRBs into the traditional mLRB index did not lead to an improvement in the prediction of the cross-sectional outcome of body weight status. When predicting low school performance, the basic model including the traditional mLRBs index achieved a prediction percentage of 79.4% ($p<0.001$), and the addition of the emerging mLRBs did not result in any improvement in the model prediction. On the contrary, incorporating both emerging mLRBs into the traditional index slightly improved the prediction by 2% for the cross-sectional outcome of a symptom of depression. The basic model including the traditional mLRBs index had a prediction percentage of 67.2% ($p<0.001$), while the final model including all traditional and emergent mLRBs showed a prediction of 69.2% ($p<0.001$). Lastly, the most prevalent unique combination without repetition using these six mLRBs for NCDs was with four risk behaviors: insufficient PA + unhealthy Diet + increased RSST + insufficient ST. This unique combination accounted for 18.37% of our local sample.

5.3. Aims Discussion

5.3.1. Prevalence of Traditional and Emerging mLRBs for Non-Communicable Diseases among a Local Sample – (Aim #1)

Among Hispanic/Latino adolescents living along the U.S.-Mexico border region in El Paso County, Texas, the overall results from the 2019 local survey revealed the presence of mLRB for NCDs in our region. Specifically, the four traditional mLRBs DIET (~79%), PA (~70%), TOB (~23%), and OH (~19%) and the two emergent mLRBs, ST (~64%) and RSST (~63%). Overall traditional and emerging mLRB and by sex are displayed in Table 4.2.

When stratifying by sex, results from this study showed that more males engaged in physical activity behaviors (attendance to physical education class 5 days a week and physical activity for 60 minutes or more per day on all 7 days of the week) when compared to females (Table 4.2). Van Sluijs and coworkers studied accelerometer data from US and European youth and found that boys were more active than girls on both regions (van Sluijs et al., 2021); Furthermore, the authors concluded that regardless of sex there is a trend for decreasing physical activity behaviors with advancing age in early and late adolescence, which proves the value of a continuous health surveillance system (van Sluijs et al., 2021).

A similar study, the LOOK study by Telford et al., assessed the effects of different levels of influence to include environment, family and individual, on youth's physical activity. That study concluded that weaker influences at the three levels were associated to the lower physical activity among girls (Telford et al., 2016). Results from the Georgia Student Health Survey 2.0 suggests that females that were physically active were more likely to experience peer victimization (bullying) while male adolescents who were less physically active reported a

higher prevalence of peer victimization. (Rajbhandari-Thapa et al., 2022). The disparity could be explained by the perceived gender norms from the participants' environment.

On a study of 64 global south countries that surveyed the number of days in the past week adolescents were physically active for at least 60 minutes aimed at describing gender inequalities in physical activity. Results indicated that the prevalence of physical activity was 6.7 percentage points higher in boys than in girls and the pooled ratio for all countries showed that boys presented a physical activity prevalence 1.58 times higher than girls (95%CI: 1.47–1.70) on average. The authors concluded that girls are mostly less active than boys across the globe (Ricardo et al., 2022).

Our findings are consistent with the previously cited studies in where regardless of other factors such as increased age adolescent females are less physically active that their male counterparts. Our findings provide the basis to create a plan to empower female adolescents as an initial step to closing the gender gap in physical activity.

When stratified by school grades, the analysis revealed that more 9^{th} graders attended physical education (PE) classes on all 5 days in an average school week compared to 10^{th} graders (Table 4.3). Similarly, a study by Martins et al. (2020) showed that among adolescents, attendance to PE classes on 5 or more days decreases as age increases. The decrease in prevalence, accompanied by an increase in age, was similar for both boys (21.8% to 18.5%) and girls (19.4% to 14.3%) (Martins et al., 2020).

In relation to dietary behaviors the results displayed in Table 4.2 show statistically significant differences between male and female dietary behaviors. A higher prevalence of males consuming milk and having breakfast was observed when compared to their female peers.

Several studies have documented dietary behaviors in adolescents. For example, Askovic and Kirchengast studied adolescents' nutritional habits reporting that meal size decreased among females while it increased or remained stable for males (Askovic & Kirchengast, 2012). Results from that study suggests that the differences in meal size can be attributed not only to the different energetic demands for males and females but also to cultural beauty ideals in where females might perceive that small meal size might be associated with their beauty ideals.

Our study showed that 70 % of females did not ate breakfast at least one time during the week while males showed a 50 % prevalence (Table 4.2). In a systematic review by Monzani et al., it was reported an increasing trend of breakfast skipping among adolescents, and this behavior was primarily observed among females Additionally, Monzani and coauthors indicated that children and adolescents who skip breakfast were at a higher risk to be or become overweight/obese (Monzani et al., 2019).

In addition, our study revealed that the prevalence of skipping breakfast and consuming alcohol was higher among 10th grade students when compared to their younger counterparts in 9th grade. Evidence suggests that the regular intake of a healthy breakfast positively impacts health and is essential for children and adolescents as they grow; still, people skips breakfast for various reasons around the world (Rani et al., 2021). Similar results were found on different studies, which reported that following the daily breakfast recommendation was less common among older adolescents when compared to younger ones (Ostachowska-Gasior et al., 2016; Villa-González et al., 2019; Wang et al., 2016). Regarding alcohol consumption, a study among high school students found that both current and binge drinking had notably declined over time (Esser et al., 2017). However, similar to our results, among those students who currently drank, there was a significant increase in drinking alcohol as students advanced to a higher school year.

The percentage increased progressively from 23.4% among 9th graders to 29.0% 10th graders, 38.0% among 11th graders, and 42.4% among 12th graders (Esser et al., 2017).

Sugary drinks is the largest source of added sugar to the diet in the US, and there is a disproportionally high consumption among young adults, Hispanics and African Americans (Jiang et al., 2020). Our results showed that a greater proportion of males, when compared to females, consumed at least one sugar-sweetened soda in the 7 days preceding the survey (Table 4.2). In one of the studies from the National Health and Nutrition Examination Survey (NHANES), a program of studies designed to assess the health and nutritional status of adults and children in U.S., it was shown a similar trend among youth, with boys reporting a higher percent (64.5%) than girls (61.3%) who consumed at least one sugar-sweetened beverage (Rosinger et al., 2017). Our results are consistent with those reported in NHANES.

When stratifying by body weight status, the analysis surprisingly revealed that students with no excess body weight, based on the CDC BMI-for age categories, exhibited a significantly higher prevalence on soda consumption when compared to their counterparts' students with excess weight (Table 4.4). In terms of this student's characteristic, contrary to what our local study found, the prevalence of daily consumption of regular soda was higher among overweight and obese students than those with normal weight and underweight as reported by Miller et al. (2016). Furthermore, that particular study showed a stronger association between an individual's screen time and increased consumption of regular soda (Miller et al., 2016).

In reference to sleep behavior evaluated with the statement "sleeping fewer than 8 hours during school weeknights," this behavior was higher among females compared to their male counterparts (Table 4.2). These results are similar to those reported, in a cross-sectional survey of 7308 students aged 13 to 18 years attending 245 schools in where it was reported that, on

average, girls slept for 7.60 hours on weeknight, while boys slept for 7.81 hours (Paksarian et al., 2015). The approximately 20 additional minutes of sleep among boys were associated with school start time (Paksarian et al., 2015).

Additionally, our study found that a higher prevalence of females compared to males reporting symptoms for depression such as sadness or hopeless almost every day for two weeks or more in the past year. A study based on adolescent data from the National Survey on Drug Use and Health showed that in 2009 and 2019, the prevalence of depression among females was 128% and 172% higher, respectively, than that among males (Daly, 2022). Our results are consistent with the findings by Daly, 2022. The discussion in aim 5, addresses the number of risk factors and the prevalence of depression and school performance.

In response to the Hypothesis 1.1, our local findings indeed confirm that females exhibit statistically significant higher rates of insufficient physical activity, non-attendance in physical education classes, skipping breakfast, not consuming enough milk, reporting shorter sleep time, and felling sadness or hopeless, aligning with the anticipated expectations based on the 2019 National CDC YRBSS results extrapolations. However, while there's a trend towards increased alcohol consumption, and overweight among females in our local sample, these observed differences were not statistically significant. Additionally, our local findings confirm that males exhibited statistically significant higher rates of soda consumption; however, higher tobacco use, lower fruit intake and obesity only showed a non-statistically significant trend. Regarding increased RSST and low vegetable intake, no statistically significant differences were observed between female and males Hispanic/Latino adolescents, as illustrated in Table 4.2.

In response to the Hypothesis 1.2, our local findings indeed confirm that 10^{th} graders exhibit statistically significant higher rates of non-attendance in physical education classes,

skipping breakfast, and increased alcohol consumption, aligning with the anticipated expectations based on the 2019 National CDC YRBSS results extrapolations. However, while there's a trend towards higher rates of insufficient physical activity, not consuming enough milk, tobacco use, and feeling sadness or hopeless among 10th graders in our local sample, these observed differences were not statistically significant. Additionally, our local findings observed higher rates among 9th graders for low vegetable intake, soda consumption, and obesity that were not statistically significant. Interestingly, when it comes to lower fruit intake, increased RSST, short ST, and overweight, no statistically significant differences were observed between 9th and 10th grade students, as illustrated in Table 4.3.

In response to the Hypothesis 1.3, paradoxically our local findings indeed only showed that soda consumption was statistically significantly higher among participants with non-body excess weight. Also, there were higher rates of low vegetable intake and higher alcohol consumption among non-body excess weight participants, but these observations were not statistically significant. Furthermore, a higher prevalence was observed among overweight and obese (excess body weight) participants for insufficient physical activity, non-attendance to PE classes, low fruit intake, not drinking enough milk, skipping breakfast, tobacco use, increased RSST, short ST, as well as felt sadness or hopeless; however, these observed differences were not statistically significant, as illustrated in Table 4.4.

5.3.2. A Comparative Analysis of a Local Sample to the 2019 CDC's National and State Data Stratified by School Grade – (Aim #2)

Local 9th and 10th grade students were more likely (i.e., 95% confidence interval) than national and state Hispanic students to consume less fruit and vegetable servings. When compared to African American and white youth, studies including Hispanic populations has shown a higher

intake of fruit and vegetables (F&V); however, the determinants of intake among youth populations of the same race/ethnicity are complex. (Dave et al., 2009; Moore et al., 2017). Differences in F&V intake are credited to acculturation, limited access, limited quality, limited variety, socio economic status (SES) and lack of knowledge about the benefits of its intake (Batis et al., 2011; Di Noia & Byrd-Bredbenner, 2014). The adoption of the American diet has been associated with lower F&V intake as the individuals depart from the Hispanic diet. Our study did not assessed acculturation however, it is noteworthy that over 90% of our study population was second generation Hispanic or higher, which might have an influence on the low intake of F&V when compared to Hispanic youth in state and national studies.

Higher social economic status (SES) has been associated with higher F&V intake (Dave et al., 2009; Dubowitz et al., 2008). El Paso, Texas has the largest Hispanic population rate (82%) among main cities in the U.S., it also has a lower median household income, higher poverty rate and unemployed population when compared to state and national averages (United States Census, 2021). Our study design cannot establish the causal relationship between F&V intake and SES; however, the census data from our population and our results in reference to F&V intake suggests that the relationship should be included in future studies. Sharma and Gernand (2008) studied 963 Mexican American adults in the El Paso TX region and found a low percentage of individuals eating the recommended F&V intake (8.2%), the authors found that nutrition knowledge was a good predictor for intake of water, beans, dairy, meats, and grains but not for F&V. The findings from that particular study propose acculturation and lower socio economic status as potential factors influencing F&V consumption (Sharma et al., 2008)

Our study showed improved health behaviors from local 9th and 10th grade students when compared to national and state Hispanic students, with respect to variables such as: “insufficient

PA", "imperfect attendance to PE", "no drinking milk", "drinking soda", and "skipping breakfast". A study on the prevalence of obesity on two geographically and demographically similar Hispanic populations of 4th grade students found a decrease in the prevalence of obesity in the city of El Paso, when compared to the Rio Grande Valley, TX region (Ezendam et al., 2011). The authors attributed the results to an improvement of physical activity, healthy diet and reduced sedentary behaviors.

Our study showed that 9th (20%) and 10th (24.7%) grade students were more likely to have used tobacco (smoking or e-cigarettes) at least one time in the 30 days before the local survey than state averages (11.9% for 9th grade; 14.5 for 10th grade) from Hispanic students. The percentage of Hispanic adults that smoke is lower when compared to other ethnicities and races across the state and the nation (O'Neil et al., 2023). However, Hispanic youth have a higher prevalence of tobacco use than white non-Hispanic (Brown et al., 2019). Low educational attainment and low income have been associated to higher rates of tobacco use (Brown et al., 2019), both characteristics of our local population. Margolis et al. (2021) reported that middle school and high school aged Hispanics had higher levels of susceptibility (i.e., lack of a strong commitment not to try a substance) to e-cigarettes (Margolis et al., 2021).

The local survey showed improved sleeping behaviors of 9th and 10th grade Hispanic students when compared to Hispanic outcomes from state and national surveys. Non-Hispanic Whites reported better sleep duration and efficiency when compared to Hispanics (Guglielmo et al., 2018). The study by Giddens et al., used Fitbit watches to monitor the sleep of 4,201 youth concluding that disparities in sleep time were partially determined by SES factors (Giddens et al., 2022). Low SES and a Hispanic ethnicity are denominators of our population; however, there is

not a clear factor that would explain why Hispanic youth in our survey did fairly better that Hispanic youth from state and national surveys in sleep.

In addition, Troxel et al., 2017, reported that home environment including neighborhood-level crime and disruption were associated to an increased risk of trouble sleeping (Troxel et al., 2017). Similarly, other authors suggested that neighborhood factors such as noise and safety could have an influence on health behaviors (DeSantis et al., 2016). The crime rates and perceptions of crime in Canutillo, TX are lower than the Texas and U.S. average (Castaneda-Tinoco & Chiappetta, 2020) which suggests that the local Hispanic students live in a safer community which could positively influence their sleep quality when compared to their state and national counterparts.

In response to the Hypothesis 2, the local sample exhibited 6 mLRBs for 9th graders and 7 mLRBs for 10th graders that significantly differ from the prevalence estimates reported by the CDC National and Texas CDC YRBSS for the same year. In summary, our findings indeed confirm that local 9th and 10th graders exhibited statistically significant lower rates for insufficient physical activity, not consuming enough milk, alcohol consumption, and short sleep time, when compared to their national and state peers' averages on the same year. Also, the local 9th and 10th graders sample displayed statistically significant lower non-attendance to PE classes and soda consumption than their national counterparts, only 10th graders did statistically significantly better than their state peers. Interestingly, the local 9th and 10th graders exhibited statistically significantly higher use of tobacco than the state peers' averages, but statistically significantly lower than the national peers' averages, as shown in Tables 4.5 and 4.6.

5.3.3. Meeting Movement Behavior CDC's Guidelines: Analysis of 'Healthy 24-Hour Periods among a Sample of Hispanic/Latino American Adolescents – (Aim #3)

Meeting recommendations and adhering to the three codependent habitual lifestyle behaviors (e.g. PA, RSST, ST) known as the healthy 24-hour period supports disease prevention and health promotion across the lifespan (Huerta-Uribe et al., 2023; Rollo et al., 2020). In our study the analysis of the healthy 24-hour behavior guidelines among a sample of 531 Hispanic/Latino American adolescents showed that adherence to recommendations for physical activity, recreational sedentary screen time, and sleep time was low (5.8%). Similar conclusions were noticed by Tapia-Serrano and colleagues (2022) in a systematic review with meta-analysis that included 63 studies from 23 countries. The authors concluded that most individuals failed to meet the three codependent behaviors that account for the 24-hour daily cycle, specially adolescents, where overall only 2.68% (95% CI: 1.78%–3.58%) of adolescents adhere to all three recommendations simultaneously (Tapia-Serrano et al., 2022).

According to the previously mentioned review, the overall non-adherence to any of the three healthy 24-hour daily recommendations among adolescents was 28.59% (95% CI: 22.42%–34.75%), which is also similar to our local proportion result (31.5%). In addition, our study found that the adherence to all three healthy 24-hour guidelines was significantly lower among females (2.7%) than among males (8.7%); a similar trend was found by Tapia-Serrano et al. with 6.89% of males complying with the three guidelines versus only 3.75% of females (Tapia-Serrano et al., 2022).

The low physical activity levels in America can be a reason for the low adherence to the three healthy 24-hour habitual behavior (Bleyer et al., 2008; Martins et al., 2020). Our study showed a reduction in physical activity as teenagers get older (Table 4.7), a common adolescent

trend also observed in other studies (Martins et al., 2020). Another potential reason is the increased access to technological devices and augmented screen time by adolescents. (Rosen et al., 2014)

The local Hispanic/Latino adolescent population (5.8%, 95% CI 3.81–7.78) performed significantly better than a national Hispanic/Latino adolescent sample (4.0%, 95% CI 3.5–4.4) when comparing the overall prevalence of the healthy 24-hour period (Knell et al., 2019). A study among Spanish adolescents reported similar low tendencies; only 5.4% of these adolescents (5.9% males and 4.8% females) met all three healthy 24-hour habitual behavior guidelines (Tapia-Serrano et al., 2021). However, the difference between males and females in the study by Tapia-Serrano (2021) was not significantly different, unlike what was observed in our local study.

The observed difference in performing better in our local sample was primarily driven by the prevalence of the healthy 24-hour period among males in our local sample (8.7%, 95% CI 5.7–12.7), which was significantly higher than the reported national value (5.4%, 95% CI 4.7–6.1) (Knell et al., 2019). This higher proportion of male meeting all three healthy 24-hour behaviors has also been reported in other emerging studies, and the sex differences were typically not statistically significant (Knell et al., 2019; Roberts et al., 2017; Zhu et al., 2020).

The concept of healthy 24-hour habitual behaviors includes three codependent movement/non-movement lifestyle behaviors (i.e., appropriate physical activity, recreational sedentary screen time, and sleep), and its analysis has been gaining prominence in the literature. Meeting all three guidelines has previously been associated with better cardiometabolic and cognitive health (Carson et al., 2017; Katzmarzyk & Staiano, 2017; Walsh et al., 2018). Specifically, not adhering to the healthy 24-hour habitual behaviors was associated with the

greatest likelihood of obesity and overweight among adolescents (Zhu et al., 2020). However, our current study only reveled a tendency, with no statistically significant difference, that the prevalence of not meeting any of the healthy 24-hour behavior guidelines was higher among students with increased weight status (i.e., overweight/obese).

In response to Hypothesis 3, our local sample indeed confirms that the proportion of adolescents meeting the 24-hour Movement Behaviors (24-h MBs) concept was statistically significantly higher than the reported estimates of a national Hispanic/Latino adolescent sample. Furthermore, the local male adolescents also showed statistically significant differences with a higher proportion when compared to the national estimates for males. However, no statistically significant difference was observed for female adolescents.

5.3.4. Traditional and Emerging mLRBs for NCD: A Two-Step Cluster Analysis among a Local Sample of Hispanic/Latino American Adolescents – (Aim #4)

There is growing interest in researching the clustering of lifestyle risk factors that increase health risk among individuals, particularly those known as the "Big Four" or, hereafter, traditional modifiable lifestyle risk behaviors (Traditional mLRBs), which include physical inactivity, poor diet, tobacco use, and alcohol consumption (Caldeira et al., 2023; Ng et al., 2020; Peters et al., 2019). Moreover, recent evidence has identified insufficient sleep time and increased recreational sedentary screen time as predictors of adverse health outcomes (Fang et al., 2019; Itani et al., 2017; Poses-Ferrer et al., 2022; Simon et al., 2019); hereafter emerging mLRBs. Complex relationships exist among behavioral risk factors, and evidence suggests that they tend to co-occur or cluster together within populations, with a further synergistic effect detrimental to health (Cook et al., 2020; de Winter et al., 2016; Noble et al., 2015). However,

there is limited research reported on cluster analysis of traditional and emerging mLRBs among Hispanic/Latino Adolescents living in the US-Mexico border region.

Both traditional and emerging mLRBs are preventable risk factors for NCDs (Budreviciute et al., 2020; Börnhorst et al., 2015; Ng et al., 2020; Peters et al., 2019; Seo & Shim, 2019) [cite WHO, 2021a-2023]. In order to identify high-risk groups among Hispanic/Latino school-going adolescent, we performed the TSC analysis on both the original and the imputed datasets. Our finding revealed that the majority of surveyed students did not meet the recommended guidelines for individual healthy behaviors. On the contrary, we observed that most Hispanic/Latino adolescents exhibited at least one or more of the traditional or emergent mLRBs. By including the four traditional mLRBs (physical activity, diet, tobacco use, alcohol consumption) and the two emerging mLRBs (recreational sedentary screen time and sleep time) as input variables, we identified consistent evidence of five distinct and well-defined clusters in our local sample.

To our knowledge, this is the first study to investigate the clustering of six risk behaviors (PA, DIET, TOB, OH, RSST, ST) for non-communicable diseases among Hispanic/Latino adolescents attending to 9^{th} or 10^{th} grade in the US-Mexico border region. However, comparisons of the findings of the present study with similar studies should be made with caution due to both the difference in investigating the different risk factors and the difference in the definition of terms and cut-off points for the dichotomization of the risk behaviors, as well as the age group and the recruited populations.

Based on the results of the TSC analysis, five distinct and mutually exclusive clusters were found among our local sample of students with the original dataset that excluded the incomplete cases as well as with the imputed datasets (Table 4.9 and 4.10). According to the

number of marked as at-risk lifestyle behaviors, the five distinct clusters were: cluster 2 mLRBs: lowest health risk, cluster 3 mLRBs-E: low health risk, cluster 3 mLRBs-T: moderate health risk, cluster 4 mLRBs: high health risk, and cluster 6 mLRBs: highest health risk. It is worth noting that less than 20% of the sample fell into the cluster 2 mLRBs (lowest health risk), the most favorable lifestyle pattern or healthier cluster. Conversely, more than half of the sample (~52%) were grouped to cluster 4 mLRBs (high health risk) or 6 mLRBs (highest health risk); the two most unfavorable lifestyle or unhealthiest patterns for health.

Although NCDs are primarily detected during adult life, many of their precursors begin during childhood and adolescence. The high prevalence of students within the unfavorable lifestyle behavior patterns shows the pressing need for early interventions aimed at promoting healthier lifestyles among Hispanic/Latino adolescents (Teh et al., 2019). Similar results were found by Dumith et al., (2012), when they investigated the clustering of traditional mLRBs (smoking, alcohol intake, low fruit intake, and physical inactivity) among adolescents in Brazil. The researchers reported that more than half of their participants presented two or more risk factors and concluded that risk behaviors for NCDs tend to cluster together among adolescents (Dumith et al., 2012). Furthermore, 3 or more lifestyle risk behaviors were identified approximately among 15% of adolescents.

Previous research has shown that commonly used substances among adolescents are alcohol, cannabis, and tobacco products (Halladay et al., 2020). In the present study, it was observed that alcohol consumption and tobacco use cluster together along with the other health risk behaviors analyzed in here. This 6 mLRBs cluster exhibited a high prevalence of depression symptoms and low school performance among its members. Similarly, Dumith et al. (2012) highlighted the tendency of for behavioral risk factors, specifically smoking and alcohol intake,

to cluster together (Dumith et al., 2012). This finding underscores the importance of early detection and education that prevent adolescents from engaging with these behaviors, as one behavior can lead to another, and these lifestyle patterns may persist into adulthood.

The cross-sectional outcome cluster comparisons were conducted for the TSC results obtained using from the original data (Table 4.11), as well as for the TSC results obtained from the imputed data (Table 4.12) separately. Students who were classified in the cluster with the highest number of mLRBs, compared to those who were classified in the cluster with the lowest number of mLRBs, showed a higher likelihood of self-reporting adverse health-, mental-, and school-related outcomes. Sunderland et al. reported similar results while studying Australian youth (11-17y) showing an increase in the prevalence of depressive disorders related to the increase in lifestyle risk factors (e.g., high BMI, alcohol use, tobacco use, poor sleep, sedentary time, poor diet, and physical activity). Similar results were obtained for school performance outcome, students that reported grades of C or lower had higher percentages of all mLRBs (Sunderland et al., 2021).

5.3.5. Prevailing Patterns & Association Between Traditional and Emergent mLRBs for NCDs Indexes with Cross-sectional Outcomes among a Local Sample – (Aim #5)

Based on the imputed dataset, our cross-sectional intermediate outcomes show that for weight status there was a significant difference in PA and OH and ST percentages between students with BMI above or below the 85th percentile. A higher ratio of students with BMI above 85th percentile incurred in insufficient physical activity and sedentary time; both risk factors have been previously associated to weight status (Cureau et al., 2018; Liberali et al., 2021). For instance, using data from Brazil, Portugal, Canada, Italy, Australia and the United Staes, Liberali et al (2021) reported an association between obesity and risk factor clusters of low physical

activity, low fruit and vegetable consumption, low sleep time, high consumption of fatty foods, and high sedentary and screen time (Liberali et al., 2021).

Our cross-sectional results also showed non statistical differences in TOB, DIET and RSST between students with BMI above or below the 85th percentile. Nevertheless, for weight status the students with high BMI (≥85th percentile) reported a lower consumption of alcohol than students with lower BMI (Table 4.14). Studies have shown that moderate alcohol consumption does not seem to be associated with obesity, heavy drinking on the other hand may promote overweight and obesity (Tolstrup et al., 2005). Puhl and Heuer propose that adolescents with higher BMI have less probability to access addictive substances due to a higher level of social isolation than their peers (Puhl & Heuer, 2009).

The cross-sectional outcomes for depression symptoms show that among students who identified as sad or hopeless had higher percentages of all mLRBs (Table 4.14). There is a well-established association between depression and various lifestyle risk factors. Sunderland et al studied a representative sample of Australian youth (11-17y) and reported that all of their studied lifestyle risk factors (e.g. high BMI, alcohol use, tobacco use, poor sleep, sedentary time, poor diet and physical activity) were related with increased occurrence of major depressive disorder (Sunderland et al., 2021). Similarly, the cross-sectional outcomes for school performance also show that among students who had grades of Cs or lower, they had higher percentages of all mLRBs (Table 4.14). Physical inactivity, tobacco and alcohol use and dietary behaviors are linked to low educational attainment (National Academies of Sciences, 2020). Reduced sleep time and increased screen and sedentary time have also been associated to poor grades (Alfonsi et al., 2020; Fan et al., 2022).

Table 4.15 shows how as the co-occurrence of traditional mLRBs increases the percentage of students that experience screen time and reduced sleep also increase. Multivariate logistic regression models from the National Health and Nutrition Examination Survey corroborate the concurrence of risk factors. Xu et al. reported that adolescents not in compliance with the physical activity recommendations had 50% higher odds of having sufficient sleep. In addition, respondents not meeting screen time recommendations had a 55% higher probability of poor sleep quality. However, adolescents not meeting both physical activity and screen time had 73% higher probability of showing bad sleep quality (Xu et al., 2019).

Studies have shown high (>70%) co-occurrence of risk factors in youth populations which suggests a synergistic effect on health outcomes (Cureau et al., 2018; Uddin et al., 2020). Our results (Table 4.16) show that the majority of participants (88.9%) had at least two risk factors simultaneously. Among our local sample of Hispanic/Latino American adolescents, it is observed that higher index scores of mLRBs were more prevalent among females (3 to 6 mLRBs) and those in the 10^{th} grade (3, 5 and 6 mLRBs). Uddin et al. studied the clustering of lifestyle risk factors in adolescents from 89 countries and reported that adolescents aged 16-17 years had higher probability of reporting three or more risk factors when compared to youth aged 11-13 years (Uddin et al., 2020). Teh et al (2019) investigated the clustering of lifestyle behaviors in adolescents from Malaysia, a middle-income country. Similar to our results the authors reported that females showed a higher probability to have clustered risk behaviors when compared to males (Teh et al., 2019). Uddin et al. also showed that the co-occurrence of risk factors in adolescents (e.g. smoking, drinking, low fruit/vegetable intake and physical inactivity) was 45 % greater in females (Uddin et al., 2020).

When calculating the potential combinations of the four traditional and two emergent mLRBs among our sample, the most prevalent combination with 18.37% of the sample had four risk factors: physical activity, diet, screen time and sleep time (Table 4.18). Uddin et al investigated the clustering of risk factors in a sample of 304,779 adolescents and although the authors didn't include screen time and sleep time, their most prevalent combination of lifestyle risk factors were physical inactivity and poor diet (Uddin et al., 2020). Two combinations of three mLRBs (e.g., PA+DIET+RSST and PA+DIET+ST) were the next in prevalence with 8.9%.

The combination and number of the risk factors analyzed in this study have been associated with all-cause mortality in other publications (Ford et al., 2011; Khaw et al., 2008). Furthermore, risk behaviors in adolescents cluster in specific patterns and its synergy could cause worse health outcomes than the addition of individual risks. For example, alcohol consumption and smoking had the smallest single risk prevalence with 19.0% and 22.6%, respectively (Table 4.14). However, in the cross-sectional intermediate outcomes analysis both OH and TOB co-occur with the other four risk factors, resulting in the observation that of the greatest distinction between what would be considered at "lower" and at "highest" risk group the depression symptoms and school performance outcomes (Table 4.16). Ding et al., found synergistic effects when including alcohol consumption and smoking in their clusters. The authors found an increased mortality risk when the two risk factors (e.g. smoking and alcohol consumption) were paired together (Ding et al., 2015).

In response to Hypothesis 5, the models using an adolescent lifestyle health risk index that includes the two emergent mLRBs alongside the four traditional mLRBs showed fair to good prediction for two out of the three cross-sectional outcomes selected in this study. Adding the emerging mLRBs to the traditional model did not significantly predict the body weight status

outcome. However, when RSST and ST where added, models showed a good significatively prediction (79.4%) to low school performance in the local sample. Furthermore, the basic model showed a fair significatively prediction (67.2%) for the symptom of depression and with inclusion of both emerging mLRBs slightly enhanced the model prediction to (69.2%), as displayed in Tables 4.17.

To our knowledge, this is the first study to investigate the clustering of six risk behaviors (PA, DIET, TOB, OH, RSST, ST) for NCDs among Hispanic/Latino adolescents attending to 9th or 10th grade in the US-Mexico border region. However, comparisons of the findings of the present study with similar work should be made with caution. (i.e., please refer to the limitations section).

5.4. Limitations

The present study has limitations that should be considered. This secondary data analysis is a dissertation project exploring the occurrence and co-occurrence of lifestyle risk behaviors for NCDs within a specific Hispanic/Latino adolescent population. The study relies on data from parental/original cross-sectional research involving high school adolescents enrolled in 9th and 10h grade who participated in a self-reported online survey. While this approach allows for the utilization of existing data, conducting secondary data analysis presents inherent limitations, and may result in data gaps, variable inflexibility, and potential sampling biases. The process of ensuring the secondary data aligns with the proposed research questions and variables of interest depends on the quality of secondary data depends on the rigor and comprehensiveness of the original data, leading to a lack of generalizability for the broader population.

Additional limitation lies in the reliance on participants' self-reported lifestyle risk behaviors at a single time point. Cross-sectional designs, by nature, offer only a snapshot of

information at a specific point in time, making it difficult to establish causal relationships, track changes or habitual behaviors over time. In addition, the use of online surveys introduces potential sources of bias. Online surveys can suffer from sampling bias, as they often rely on non-random samples of participants and those who are more active or accessible online may be overrepresented. Also, respondents in online surveys choose to participate, which can lead to self-selection bias, and that could potentially skew the results. Another limitation lies in the unique demographic and cultural attributes of the local region could introduce selection bias into the study, affecting the generalizability of the findings.

Although using established and validated questions, the self-reported nature of the survey introduces potential sources of bias. While the questionnaires assured confidentiality, it remains a possibility that respondents might have felt reluctant to disclose their engagement with risk behaviors and bias attributable to nonparticipation should also be considered. Additional limitation lies from the targeted population. Adolescents, particularly high school students, might be influenced by social desirability, peer pressure, or difficulties in accurately recalling their experiences, and these can affect the accuracy of their self-reported. Also, variability in language and communication styles among adolescents can pose challenges in interpreting the survey questions accurately. The self-reported data can potentially lead to both overestimation and underestimation of risk behaviors, as well as lead to limitations in the understanding of lifestyle risk behaviors. Also, the sample was not well representative considering the limited age range addressed in this study which underscores the importance of employing caution when extending these findings to a broader adolescent population.

Moreover, the conversion of the original variables into a binomial format using cut-off points might restrict alternative approaches to data interpretation. In addition, the assessment of

various risk behaviors lacks specificity and the timeframes varied. For instance, the alcohol measure solely encompasses short-term alcohol consumption (i.e., 30 days), failing to differentiate between heavy and light drinkers, and account for binge drinking. The dietary assessment encompassed only a limited selection of food items, and portions were not specific. The sleep measure solely focused on sleep quantity, without considering other facets of sleep quality. The assessment of sedentary behavior solely accounts for screen time not related to school-related activities without accounting for prolonged sitting. Additionally, the smoking measure failed to consider all forms of tobacco products such as cigars, pipes, smokeless tobacco (i.e., chewing tobacco), dissolvable tobacco (i.e., pouches) among others.

Finally, it is essential to recognize the limitations associated with this project. Researchers should approach the results with caution, considering the constraints related to the study design, data collection methods, the use of secondary data, targeted population, and measurement limitations. All these limitations can impact the generalizability and depth of our findings, and caution should be taken when making inferences about the study, particularly when extrapolating multiple or co-occurrence of risk behaviors. Despite these limitations, this dissertation research is a valuable contribution to our understanding of modifiable lifestyle risk behaviors among Hispanic/Latino American adolescents in the U.S.-Mexico border region and shedding light on our understanding of health disparities in this unique and vital population.

CHAPTER 6: CONCLUSION

The primary goal of this research was to investigate modifiable lifestyle risk behaviors (mLRBs) associated with non-communicable diseases (NCDs) among adolescents, specifically focusing on the four traditional mLRBs, such as physical activity, dietary behaviors, tobacco use, and alcohol consumption, and two emerging mLRBs, including recreational sedentary screen time and sleep time. This secondary data analysis project used data (n=539 students) from the 2019 El Paso YHBS cross-sectional study. The selected participants included 52% male and 48% female Hispanic/Latino adolescents enrolled in 9th grade (44%) and 10th grade (56%), living in the U.S.-Mexico border region within El Paso County, Texas.

In reference to traditional mLRBs, results from this secondary data analysis revealed that a substantial proportion of adolescents did not engage in sufficient daily physical activity (70%), did not meet daily dietary recommendations (79%), and a fraction used tobacco products (23%), or consumed alcohol (17%) in the past 30 days. In terms of emerging mLRBs, a considerable proportion of adolescents reported increased recreational sedentary screen time on an average school day (63%) and had reduced sleep time on an average school night (64%).

Overall, our results revealed that a significant proportion (97.6%) of Hispanic/Latino American adolescents in the study had not met one or more of the recommended CDC guidelines for mLRBs, thus indicating a potential health risk among the targeted population during adolescence and a likely increased risk for the development of NCDs during adulthood.

Stratification by sex, school grade, and body weight status allowed for the identification of differences in behavior prevalence, particularly among female adolescents and 10th grade students. Local Hispanic/Latino female adolescents exhibited a higher prevalence of five mLRBs, which included insufficient physical activity, non-attendance to PE classes, avoiding

milk drinking, skipping breakfast, and undergoing short sleep time. Additionally, they reported a higher prevalence of feelings of sadness or hopelessness compared to their male counterparts, who exhibited a higher prevalence of soda consumption. Among 10th grade students, a higher prevalence of three specific mLRBs was observed in comparison to 9th grade students, comprising non-attendance of PE classes, skipping breakfast, and alcohol consumption. Paradoxically, it was found that soda consumption was higher among students who were not overweight or obese when analysis was based on body weight status.

Additionally, we compared our local findings to the reported data in the 2019 CDC YRBSS for the Hispanic/Latino population. Despite local students showing a poorly met of the CDC recommended standards for mLRBs and exhibiting similar trends as the state and national average, differences in behavior prevalence were unveiled. In this analysis, the local sample (including both 9th and 10th grade students) revealed more favorable outcomes in four specific mLRBs— comprising physical activity, drinking milk, alcohol consumption, and sleep time— when compared to state and national averages. Also, although the local sample displayed a more favorable prevalence in PE classes and soda consumption than their national counterparts, only 10th graders outperformed their state peers. Conversely, the prevalence of tobacco use among the local sample was worse than the state averages but better than the national averages.

The inclusion of the 24-hour movement behaviors (24-MBs) concept provided a broader perspective on compliance with three health-related behaviors, encompassing guidelines on physical activity, recreational sedentary screen time, and sleep time. Our results indicated that a limited percentage of participants (5.8%) met all three combined 24-MBs guidelines. In contrast to their national counterparts, the study found sex-specific differences in compliance, where local

adolescents, specifically males, exhibited higher compliance with this 24-MBs concept when compared to their national counterparts.

To better understand how traditional and emerging mLRBs co-occur among our local high school students, we conducted a cluster analysis, identifying distinct groups with varying levels of at-risk behaviors. Cluster analysis revealed five distinct groups, indicating the co-occurrence of these behaviors among the local sample. These clusters were labeled based on the number of mLRBs marked as at-risk (i.e., 2 mLRBs, 3-E mLRBs, 3-T mLRBs, 4 mLRBs, and 6 mLRBs). Notably, with this analysis it was observed that participants in clusters with higher numbers of at-risk behaviors were more likely to self-report adverse outcomes, including overweight, symptom of depression, and low school performance.

Moreover, we also explored the inclusion of the two emerging mLRBs (RSST and ST) alongside the four traditional mLRBs to form an adolescent lifestyle risk index. Incorporating the traditional mLRB index as the basic model and combining the emerging mLRBs resulted in three additional models that allowed us to observe their impact on classifying cross-sectional outcomes. Initially, it was observed that with an increase in the number of traditional mLRBs engaged by students, the prevalence of RSST and ST also increased. The models showed fair to good prediction for two out of the three cross-sectional outcomes. However, adding emerging mLRBs did not significantly improve the models' prediction of body weight status or low school performance in the local sample. Nevertheless, the inclusion of both emerging mLRBs slightly enhanced the model prediction of the symptom of depression.

In summary, our study provides valuable evidence into the prevalence and lifestyle patterns of mLRBs among a sample of adolescents living in the U.S.-Mexico border region within El Paso County, Texas. The research presented in this study displays challenges and

opportunities related to traditional and emergent mLRBs for NCDs within a local sample of Hispanic/Latino American adolescents. These findings highlight the need to support tailored public health initiatives and interventions designed to address mLRBs associated with NCDs in this specific population. In the context of disease prevention, a practical lifestyle risk index over time could serve as a valuable summary tool for assessing adolescent health and evaluating the effectiveness of lifestyle health promotion interventions. Moreover, the study found the clustering of traditional and emerging mLRBs in our sample, emphasizing the importance of implementing comprehensive behavior change interventions targeting the multi-layered nature of combined mLRBs pointing at mitigate their synergistic impact and potentially influence on various health outcomes prevalent in the region. Future research employing a longitudinal design should be conducted to investigate the impacts of both emerging and traditional mLRBs alongside a lifestyle risk behavior index in order to improve the health of local adolescents and contribute to the prevention of non-communicable diseases among the Hispanic/Latino population.

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APPENDIX A

List of variables used in this secondary data analysis project derived from the parent/original 2019 EP YHRB study. Responses of interest (ROIs) used to recode the dichotomized variables are bolded. ROIs for both traditional & emergent MLRBs variables denote the behaviors considered at-risk, reflecting when the CDC recommendations were not met for adolescents. Cross-sectional outcomes ROIs depict health-related outcomes of interest. Additionally, ROIs for eligibility criteria and other variables indicate the levels used for inclusion, generation of other variables, or measures for quality control.

2019 El Paso YHBS Question	**Variable Name**	**Original Question**	**2019 CDC National Question Number**	**Variable Type & Response % (n)**	**Code /Levels** (The **bolded** responses options indicate the **ROIs** used for the dichotomized question)
0	Consent form	I understand that this surveillance survey is completely voluntary. I know that it is anonymous, and nobody can connect my answers to myself or my name. I know I can skip any question I do not wish to answer. I know I can stop taking the survey at any time.	-	Binomial/ Categorical	**A. Yes, I want to continue to the survey.** B. No, I do not want to do the survey.
1	Age	How old are you?	Q1	Ordinal/ Categorical 97.8 (806)	**A. 13 years old** **B. 14 years old** **C. 15 years old** **D. 16 years old** **E. 17 years old** F. 18 years old or older Missing = leave blank
2	Gender	What is your sex?	Q2	Binomial/ Categorical 95.8 (789)	A. Female B. Male Missing = leave blank
3	Employed	Do you currently work or have a job?	-	Binomial/ Categorical 95.0 (783)	A. No B. Yes Missing = leave blank
4	School grade	In what grade are you?	Q3	Ordinal/ Categorical 95.5 (787)	**A. 9th grade** **B. 10th grade** C. 11th grade D. 12th grade Missing = leave blank

5	School performance	During the past 12 months, how would you describe your grades in school?	Q89	Ordinal/ Categorical	A. Mostly A's B. Mostly B's **C. Mostly C's** **D. Mostly D's** **E. Mostly F's** F. None of these grades G. Not sure Missing = leave blank
7	Hispanic/Latino	Are you Hispanic or Latino?	Q4	Binomial/ Categorical 94.4 9(78)	A. No **B. Yes** Missing = leave blank
8	US-born	Were you born in the USA?	-	Binomial/ Categorical 94.4 (778)	A. No **B. Yes** Missing = leave blank
10	US-parents	Were your biological parents born in the USA?	-	Nominal/ Categorical 94.1 (778)	**A. Yes, both of my parents were born in the USA.** B. Only one of my parents was born in the USA. C. No, both of my parents were born outside of the USA. D. Don't Know/Not Sure Missing = leave blank
11	US- maternal grandparents	Were your biological maternal (mother) grandparents born in the United States?	-	Nominal/ Categorical 93.8 (773)	**A. Yes, both of my maternal grandparents were born in the USA.** B. Only one of my maternal grandparents was born in the USA. C. No, my two maternal grandparents were born outside the USA. D. Don't Know/Not Sure Missing = leave blank
12	US- paternal grandparents	Were your biological paternal (father) grandparents born in the United States?	-	Nominal/ Categorical 94.3 (777)	**A. Yes, both of my paternal grandparents were born in the USA.** B. Only one of my paternal grandparents was born in the USA. C. No, my two paternal grandparents were born outside the USA.

					D. Don't Know/Not Sure Missing = leave blank
New	Hispanic Generational Status	Classified according to the United States Census Bureau based on the 3 previous items	-	Nominal/ Categorical	A. First or higher B. Second or higher C. Third or higher D. Fourth or higher generation Missing = leave blank
13	Speak English	How well do you speak English?	Q99	Ordinal/ Categorical 94.5 (779)	**A. Very well** **B. Well** C. Not well D. Not at all Missing = leave blank
14	Other language	How often do you speak a language other than English at home?	-	Ordinal/ Categorical 94.7 (780)	**A. Never** **B. Less than half the time** C. About half the time D. More than half the time, but not all of the time E. All of the time Missing = leave blank
15	Height	How tall are you without your shoes on?	Q6	Numeric/ Continuous 87.6 (722)	Enter number. Missing = leave blank
16	Weight	How much do you weigh without your shoes on?	Q7	Numeric/ Continuous 79.4 (654)	Enter number. Missing = leave blank
New	BMI	Calculated Body Mass Index	-	Numeric/ Continuous 77.4 (638)	Calculated number. Missing = leave blank
19	Fruit	During the past 7 days, how many times did you eat fruit? (Do not count fruit juice.)	Q69-70	Ordinal/ Categorical 95.0 (783)	**A. I did not eat fruit during the past 7 days** **B**. 1 to 3 times during the past 7 days **C.** 4 to 6 times during the past 7 days D. 1 time per day E. 2 times per day F. 3 times per day G. 4 or more times per day Missing = leave blank
20	Vegetables	During the past 7 days, how many times did you eat vegetables? (Do not	Q71-74	Ordinal/ Categorical 94.3 (777)	**A. I did not eat other vegetables during the past 7 days.**

		count French fries, fried potatoes or potato chips)			**B.** 1 to 3 times during the past 7 days **C.** 4 to 6 times during the past 7 days D. 1 time per day E. 2 times per day F. 3 times per day G. 4 or more times per day2 Missing = leave blank
21	Soda	During the past 7 days, how many times did you drink a can, bottle, or glass of soda or pop, such as Coke, Pepsi, or Sprite? (Do not count diet soda or diet pop.)	Q75	Ordinal/ Categorical 94.9 (782)	A. I did not drink soda or pop during the past 7 days. **B. 1 to 3 times during the past 7 days** **C. 4 to 6 times during the past 7 days** **D. 1 time per day** **E. 2 times per day** **F. 3 times per day** **G. 4 or more times per day** Missing = leave blank
22	Milk	During the past 7 days, how many glasses of milk did you drink? (Count the milk you drank in a glass or cup, from a carton, or with cereal. Count the half pint of milk served at school as equal to one glass.)	Q76	Ordinal/ Categorical 94.7 (780)	**A. I did not drink milk during the past 7 days.** **B. 1 to 3 glasses during the past 7 days** **C. 4 to 6 glasses during the past 7 days** **D. 1 glass per day** **E. 2 glasses per day** F. 3 glasses per day G. 4 or more glasses per day
23	Breakfast	During the past 7 days, on how many days did you eat breakfast?	Q77	Numeric/ Continuous 94.3 (777)	**A. 0 days** **B. 1 day** **C. 2 days** **D. 3 days** **E. 4 days** **F. 5 days** **G. 6 days** H. 7 days Missing = leave blank
25	Exercise	During the past 7 days, on how many days were you physically active for	Q78	Numeric/ Continuous 94.4 (778)	**A. 0 days** **B. 1 day** **C. 2 days**

		a total of at least 60 minutes per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time.)			**D. 3 days** **E. 4 days** **F. 5 days** **G. 6 days** H. 7 days Missing = leave blank
27	PE-class	In an average week when you are in school, on how many days do you go to physical education (PE) classes?	Q81	Numeric/ Continuous 94.4 (778)	**A. 0 days** **B. 1 day** **C. 2 days** **D. 3 days** **E. 4 days** F. 5 days Missing = leave blank
42	Smoking	During the past 30 days, on how many days did you smoke cigarettes?	Q32	Ordinal/ Categorical 92.0 (758)	A. 0 days B. **1 or 2 days** C. **3 to 5 days** D. **6 to 9 days** E. **10 to 19 days** F. **20 to 29 days** G. **All 30 days** Missing = leave blank
43	Smoking 2	During the past 30 days, on how many days did you smoke tobacco or flavored tobacco in a hookah, even just a puff?	-	Ordinal/ Categorical 92.1 (759)	A. 0 days B. **1 or 2 days** C. **3 to 5 days** D. **6 to 9 days** E. **10 to 19 days** F. **20 to 29 days** G. **All 30 days** Missing = leave blank
48	e-Smoking	During the past 30 days, on how many days did you use an electronic vapor product?	Q35	Ordinal/ Categorical 92.1 (759)	A. 0 days B. **1 or 2 days** C. **3 to 5 days** D. **6 to 9 days** E. **10 to 19 days** F. **20 to 29 days** G. **All 30 days** Missing = leave blank
50	Drinking	During the past 30 days, on how many days did you have at least one drink of alcohol?	Q41	Ordinal/ Categorical 90.8 (748)	A. 0 days B. **1 or 2 days** C. **3 to 5 days** D. **6 to 9 days** E. **10 to 19 days** F. **20 to 29 days** G. **All 30 days**

					Missing = leave blank
26	Screen-time	On an average school day, how many hours do you watch TV, play video or computer games or use a computer for something that is not schoolwork? (Count time spent on things such as Xbox, PlayStation, an iPod, an iPad or another tablet, a smartphone, YouTube, Netflix, Hulu, Facebook or other social networking tools, and the Internet.)	Q79-80	Ordinal/ Categorical 94.1 (775)	A. I do not watch TV, play video or computer games or use a computer for something that is not schoolwork. (A= 0 hours) B. Less than 1 hour per day C. 1 hour per day D. 2 hours per day **E. 3 hours per day** **F. 4 hours per day** **G. 5 or more hours per day** Missing = leave blank
64	Sleep time	On an average school night, how many hours of sleep do you get?	Q88	Ordinal/ Categorical 94.1 (775)	**A. 4 or less hours** **B. 5 hours** **C. 6 hours** **D. 7 hours** E. 8 hours F. 9 hours G. 10 or more hours Missing = leave blank
66	Sadness/Hopeless	During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?	Q25	Binomial/ Categorical 89.9 (741)	A. No B. **Yes** Missing = leave blank

CURRICULUM VITA

Silvia Salinas Lopez was born in Mexico City, and raised in Chihuahua, Mexico. She graduated from the Autonomous University of Chihuahua (UACH) with a medical degree as a general practitioner in the summer of 2006. In the summer of 2016, Silvia completed the Master of Public Health Program at UTEP's Department of Public Health Sciences. She continued her academic career in the Doctoral Program of Interdisciplinary Health Science at UTEP. While attending the doctoral program, she held positions as a Graduate Research Associate and PhD Assistance Instructor. Silvia worked and volunteer as a graduate research assistant for the Institute of Healthy Living in the collaborative study "School-Based Surveillance System: El Paso Youth Health Behavior Survey." Silvia earned a Graduate Certificate in Applied Statistics from the UTEP's Department of Mathematical Sciences in May of 2019. She received the 2021 The University of Texas at El Paso IHS Candidacy Award, the 2021 UTEP Employer-led Professional Development Institute Service Award, the 2020 University of Texas at El Paso Cotton Trust Graduate Award, the 2019 University of Texas at El Paso Graduate School NextGen Student Award, and 2017 The University of Texas at El Paso Allien and Paul C. Davidson Scholarship Award. Silvia worked under Dr. Maria Duarte-Gardea's mentorship, and her dissertation explored the traditional and emerging modifiable lifestyle risk behaviors for non-communicable diseases in a sample of Hispanic/Latino American adolescents living in the U.S.-Mexico border region.