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RELATIONSHIP BETWEEN WEIGHT STATUS, DEMOGRAPHIC VARIABLES AND HEALTH-RELATED QUALITY OF LIFE IN NEW MEXICO ADOLESCENTS

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ABSTRACT

This study evaluated the relationship between weight status, demographic variables and HRQOL in New Mexico adolescents. This secondary analysis uses baseline data from 991 adolescents in the 9th and 10th grades enrolled in the ACTION PAC clinical trial. HRQOL was assessed using the validated Pediatric Quality of Life Inventory Version 4.0 (PedsQL 4.0). Body mass index (BMI) percentiles were calculated from anthropometric measurements, and demographic variables (age, sex, race/ethnicity and household income) were obtained via self-report. Obese adolescents (BMI ≥ 95th percentile) had lower total ($p<0.016$), psychosocial ($p<0.016$), social ($p<0.007$) and school ($p<0.007$) functioning HRQOL scores compared to the non-overweight (BMI ≤ 85th percentile) adolescents. Males reported higher total ($p<0.0001$), physical ($p<0.0001$), and psychosocial ($p<0.0001$) HRQOL scores compared to females. In multivariate models, the significant associations between weight status and sex and HRQOL were independent of ethnicity and household income. Obese

adolescents had poorer HRQOL compared to non-overweight adolescents irrespective of their sex, ethnicity and household income. Adolescent males had higher HRQOL scores compared to the adolescent females, independent of weight status, ethnicity and household income. In addressing adolescent obesity, management should pay attention to the physical and psychosocial wellbeing of the adolescents and not be confined to the disease process only.

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INTRODUCTION

Childhood and adolescent obesity, a common chronic disease, is a major public health issue affecting individuals, families and communities. It is associated with various health complications as well as with increasing health care costs. According to the HealthyPeople initiative, obesity is one of the leading national health indicators and a reduction from 16.1% to 14.5% in the proportion of children and adolescents (ages 2 to 19) in the United States who are obese is the target by 2020 [1, 2].

According to the National Heart, Lung and Blood Institute (NHLBI; 2010), "overweight and obesity are defined as an excess of body weight for a particular height from fat, muscle, bone, water, or a combination of these factors" [3]. For adults, overweight and obesity are also defined based on body mass index (BMI), which is measured by dividing the body weight in kilograms by height in meters squared (kg/m^2). Although BMI can estimate obesity prevalence at a population level, it may not take into consideration the differences in body fat distribution in different individuals and populations [4].

As noted by the Center for Disease Control and Prevention (CDC), age- and sex-specific BMI percentiles are used to define overweight and obesity in the pediatric age population because children's body composition changes as they get older and is different between boys and girls. Thus, BMI is expressed relative to other children of the same age and sex using growth charts and is classified as follows: children and adolescents with a BMI at the 85^{th} percentile to less than

the 95th percentile for age and sex are considered overweight. Those with a BMI at or greater than the 95th percentile are considered obese [5]. The CDC-2000 growth chart, which is widely used, was developed from five cross-sectional surveys in the United States (U.S.) between 1963 and 1994 to assess the nutritional status of U.S. children [6].

Obesity is influenced by various factors, including personal factors such as a family or personal history of obesity, metabolism, beliefs, attitudes, taste preferences, diet and physical activity behaviors, cultural experiences, socioeconomic status, and by community level factors such as the environment [7]. Environmental factors include the “home, school, [and] community” food environment, while societal factors include “cultural norms, social networks, technological development, economics, and public policy” [8].

EPIDEMIOLOGY

As reported by Raj (2012), “the worldwide prevalence of childhood overweight and obesity increased from 4.2% in 1990 to 6.7% in 2010 and is expected to reach 9.1% or 60 million in 2020” [9]. Based on reported data [6], the estimated prevalence of childhood and adolescent overweight and obesity varies in different countries (Table 1).

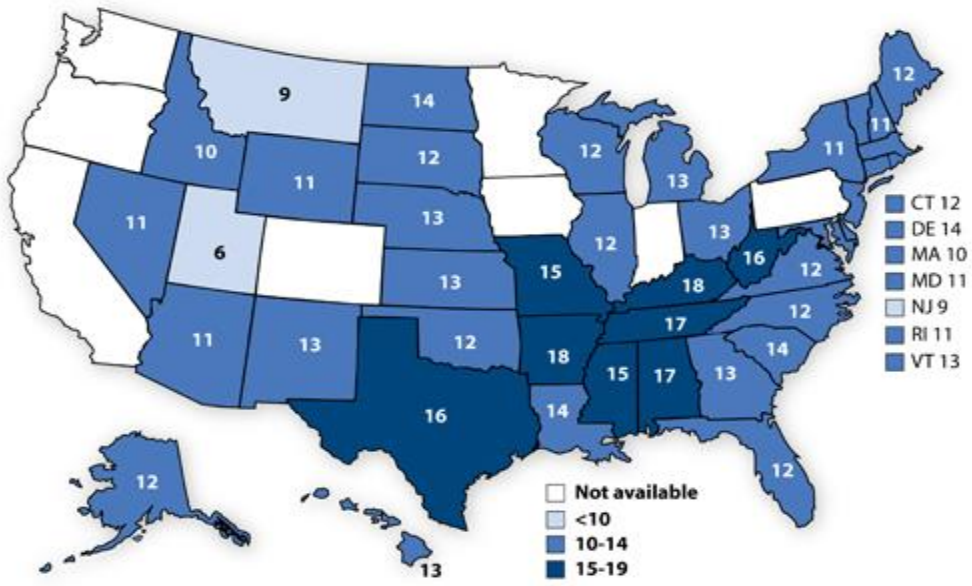
Table 1: Prevalence of overweight and obese children and adolescents (ages 10-19 years) in some countries worldwide

Country	Overweight (%)	Obese (%)	Year reported
Australia	17.9%	5.3%	2007
China	4.6%	0.6%	2008
Germany	18.2%	6.2%	2011
Italy	15.6%	2.3%	2005
Mexico	21.2%	8.9%	2009
New Zealand	24.0%	10.2%	2010
Saudi Arabia	17.9%	7.0%	2010
South Africa	14.4%	5.3%	2010
Sweden	15.8%	4.4%	2004
Taiwan	16.3%	6.2%	2009
USA	15.2%	16.4%	2010

A higher prevalence of overweight is noted in New Zealand, and a higher prevalence of obesity is noted in the United States. In a report by Ng et al. (2014), among children and adolescents in developed countries, the prevalence of overweight and obesity was 23.8% in males and 22.6% in females, while in the developing countries, the prevalence increased from 8.1% to 12.9% among males and from 8.4% to 13.4% among the females [10]. In the United States, according to the 2013 National Youth Risk Behavior Survey (YRBS) self-reported

data, 16.0% of adolescents in 9th through 12th grades at public or private schools were overweight and 13.9% were obese [11].

Figure 1: Percentage of high school students who were obese in selected U.S. states, Youth Risk Behavior Survey, 2013



Obesity prevalence varies among states with the highest adolescent obesity prevalence of between 15% and 19% in most of the southeastern states (Figure 1). In New Mexico, adolescent obesity is also prevalent. As of 2013, according to the New Mexico Youth Risk and Resiliency Survey (NMYRRS), which is based on self-report, 15.0% of adolescents in 9th through 12th grades were overweight and 12.6% were obese [12].

PREVALENCE OF OBESITY BY SEX

There is a sex disparity in obesity for children and adolescents. Male and female adolescents have a difference in muscle bulk and adipose tissue distribution, which is influenced by sex steroid hormones. Males have a lean body composition and central fat distribution while females have higher body fat percentage and more fat distribution at the gluteal/femoral parts of the body [13-15]. Barnes (1975) noted that muscle mass was greater in males than females at similar stages of puberty development [16]. In a report by Ogden et al. (2014), 35.1% of U.S. males aged 12-19 were either overweight or obese and 20.3% were obese while 33.8% females were either overweight or obese and 20.7% were obese [17].

PREVALENCE OF OBESITY BY RACE AND ETHNICITY

Significant racial and ethnic disparities exist in the prevalence of obesity among children and adolescents.

Table 2: Prevalence of overweight and obese adolescents in U.S. (12-19 years) by race/ethnicity

	Hispanic	Non-Hispanic White	Non-Hispanic Black	Non-Hispanic Asian
BMI ≥85th percentile	38.1%	31.2%	39.8%	24.6%
BMI ≥95th	22.6%	19.6%	22.1%	11.1%

percentile				

Nationally (Table 2), Hispanic adolescents had the highest prevalence of obesity (22.6%) in comparison to non-Hispanic Black (22.1%), non-Hispanic White (19.6%), and non-Hispanic Asian (11.1%) [17]. In New Mexico (Table 3), based on the NMYRRS, American Indian adolescents had a high obesity prevalence (18.0%) in comparison to Asian (7.7%), non-Hispanic Black (10.4%), Hispanic (12.7%) and non-Hispanic White (7.7%) [18].

Table 3: Prevalence of overweight and obese adolescents in New Mexico by race/ethnicity

	American Indian	Asian/ Pacific Islander	Non-Hispanic Black	Non-Hispanic White	Hispanic
BMI ≥85th percentile	18.3%	7.7%	13.2%	10.6%	14.9%
BMI ≥95th percentile	18.0%	7.7%	10.4%	7.7%	12.7%

Genetic factors may explain why obesity is more prevalent in some racial/ethnic groups and in some families, as certain gene expression is associated with obesity [19]. Identified obesity-related genes such as FGF2, PTEN, CDKN1A, ESR1, ADRB3 and LEP, code for different proteins, some of which regulate

appetite in different ways [19-21]. Proteins such as leptin [4], ghrelin and melanocortin 4 receptor have been implicated [22]. Some studies have suggested that genetic factors may play a role in some individuals who “gain fat when chronically exposed to certain environmental factors” [4]. These environmental factors as noted by Kumanyika (2008) “include differences in the geographic location, family size and composition, healthcare access and availability” [23]. African American and Hispanic groups have a higher prevalence of obesity and are disproportionately represented in poor communities where unhealthy energy-dense foods are less expensive, access to healthcare is difficult and physical activity can be a struggle due to unsafe neighborhoods or lack of infrastructure. Different racial/ethnic groups have different food-related beliefs, preferences, behaviors, and cultures which define them [23]. These differences could also contribute to the variation in prevalence of obesity in different racial/ethnic groups.

PREVALENCE OF OBESITY BY SOCIOECONOMIC STATUS

EDUCATION

The educational level of parents is associated with childhood and adolescent prevalence of overweight and obesity [5]. Obesity prevalence among children and adolescents is lower in households whose adult head finished high school compared to households whose adult head did not [5]. The level of education of caregivers may determine if they are aware of lifestyle choices such as healthy diets and adequate physical activities for their children. Caregivers with a higher

educational level are more likely to follow dietary recommendations and make healthier lifestyle choices [24]. One's level of education is also highly correlated with income.

INCOME

Lower socioeconomic status is associated with higher prevalence of obesity [5]. The high prevalence of child poverty in New Mexico could contribute to the childhood obesity burden [25]. Income largely determines if parents and guardians are able to afford relatively healthy meals, which may be more expensive, for their children. Family income also determines an environment to which a child is exposed. Food deserts are associated with poor neighborhoods where healthy food items such as fresh fruits and vegetables are not readily available, but less expensive calorie-dense foods such as sugar-sweetened beverages and snack foods, which can contribute to childhood obesity, are more readily available [26]. In New Mexico, about 27 out of 33 counties are considered to be food deserts [27]. This could also have a negative impact on the obesity prevalence in the state. In addition, poorer neighborhoods may have no facilities or safe areas for children to have adequate physical activity. Inadequate physical activity for children and adolescents may contribute to increased sedentary behaviors which may be associated with higher BMI prevalence [28].

BURDEN OF OBESITY

Guo and Chumlea (1999), reported that "the probability of childhood obesity persisting into adulthood is estimated to increase from approximately 20% at 4

years of age to approximately 80% by adolescence" [29]. Another study found that 87% of obese adolescents become obese adults [5]. This is associated with increased risk for chronic disease and higher health care costs, as well as poor health-related quality of life.

COST

Childhood and adolescent obesity are associated with a high economic burden. Areas of economic impact associated with obesity include direct and indirect medical costs. Direct costs results from treatment of obesity and its complications through the use of healthcare services such as inpatient and outpatient care [30]. Indirect medical cost results from productivity losses, transportation costs, and human capital costs [31]. About $14.3 billion is spent annually as direct costs of childhood obesity in the United States [32, 33]. In New Mexico, about 17,195 children are enrolled in the children's health insurance program (CHIP) and about $68 million is spent annually [34, 35]. Childhood obesity, and adolescent obesity in particular, could add to the costs of providing CHIP coverage for the state. Health care costs will continue to increase as more overweight and obese children and adolescents become obese adults [36].

MEDICAL COMPLICATIONS

Obesity affects almost all organ systems, resulting in complications such as diabetes, hypertension, and dyslipidemia, among others [37, 38]. Obesity and its complications could have an impact on the health-related quality of life of affected adolescents. Studies have documented lower health-related quality of

life (HRQOL) in overweight and obese individuals with comorbidities compared to those without and have shown significantly increasing effect on HRQOL in individuals with more comorbidities [39-41].

DIABETES

Diabetes, a major complication of childhood and adolescent obesity, results from a disorder of glucose metabolism thus leading to high blood glucose levels. Overweight and obese children and adolescents are at a higher risk of developing diabetes than normal weight children [42]. Some studies showed that overweight and obese youth with type 2 diabetes mellitus had lower HRQOL compared to healthy youth [43-45]. Impact on the HRQOL in obese children and adolescents with diabetes could be a result of the diabetes treatment, the lifestyle changes required to maintain glycemic control, as well as inadequate management of common co-morbid conditions such as depression [44, 46, 47].

Type 2 diabetes mellitus was previously thought to occur primarily in adults but it is now common in obese adolescents [48]. Incidence rates vary by ethnicity, with the Native Americans having the highest rate of 49.4%, Asian/Pacific Islanders 22.7%, African Americans 19.4%, Hispanics 17%, and non-Hispanic whites 5.6% [49]. Based on a report by the Centers for Disease Control and Prevention (CDC), about “215,000 people younger than 20 years of age in the United States were diagnosed with diabetes in 2010” [50]. According to Edate et al. (2015), “globally, an estimated 65,000 children younger than 16 develop diabetes each year, and the incidence continues to increase at a rate of 3% per year” [51]. Early

and intensive management of diabetes is necessary in adolescents to prevent macrovascular and microvascular complications such as retinopathy, neuropathy and nephropathy [52]. Interventions to address obesity and type 2 diabetes would involve making changes in diet and physical activity in schools, homes and in the community [53-57].

HYPERTENSION

The risk of developing hypertension during childhood and as young adults is higher among obese children compared to non-obese children [58, 59]. Factors which could play a role in obesity-related hypertension include “insulin resistance, sodium retention, increased sympathetic nervous system activity, activation of the renin-angiotensin-aldosterone system, and altered vascular function” [60].

DYSLIPIDEMIA

Dyslipidemia is another complication seen in overweight and obese children and adolescents. Higher levels of total cholesterol, low density lipoprotein cholesterol (LDL-C), triglycerides and lower concentrations of high density lipoprotein cholesterol (HDL-C) have been reported in this population [61, 62]. Individuals with obesity and dyslipidemia have been reported to have a lower physical function, health perception and preference-based HRQOL [39].

PSYCHOSOCIAL PROBLEMS

Psychosocial problems such as stigmatization, discrimination, emotional trauma, and depression are also associated with childhood obesity. Obese children and adolescents may feel unattractive and may not be confident in their social and athletic abilities [63]. Studies have shown certain domains of the HRQOL are more affected in overweight and obese children and adolescents than others. Some showed a greater impact on physical functioning while others showed the psychosocial domain being more affected [64, 65]. Lower self-esteem and depressive symptoms, which have been reported among overweight and obese adolescents could affect their HRQOL [66-68].

HEALTH RELATED QUALITY OF LIFE

The World Health Organization (WHO) defined quality of life (QOL) as “an individual’s perceptions of one’s position in life in the context of the culture and value systems in which one lives and in relation to one’s goals, expectations, standards, and concerns” [69]. Health-related quality of life (HRQOL) assesses the effect of health or disease on the physical and psychosocial functioning of an individual [70]. Understanding HRQOL can contribute to a better awareness of patients’ needs as well as to improved care and treatment [71].

Addressing factors that affect each measure of the HRQOL can help in developing public health intervention strategies [72]. HRQOL can be an outcome measure in weight management programs because if the HRQOL improves during or after weight management interventions, this could serve as a motivation

for continued behavioral changes even after the weight management interventions [73]. An assessment of HRQOL is necessary because healthcare providers may pay greater attention to the psychosocial domains of their patients' lives in addition to their patients' reported outcomes [74]. The physical domain of the HRQOL in children and adolescents looks at the "presence of general ailments and the ability to engage in physical activity while the psychosocial domain of the HRQOL looks at the emotional well-being, social integration and role functioning" [70]. The generic HRQOL scale assesses the different domains of the HRQOL in a healthy population while the disease specific HRQOL measure focuses on the effect of a specific health condition on each domain of the HRQOL [75]. Research has shown impairment in both the disease and generic HRQOL in overweight and obese adolescents [75-78]. Investigators have documented in both the self-report of adolescents and in parents' report, the association of obesity and impaired HRQOL. This association has been found in both clinic-based samples and community populations. A study done by Schwimmer and colleagues examined the HRQOL in a clinical sample of severely obese (defined as BMI at or above 120% of the sex-specific 95th percentile on the CDC BMI-for-age growth chart [79]) children. Using the Pediatric Quality of Life Inventory (PedsQL) 4.0 Generic Core Scales, the authors found that "severely obese children had impairment in their physical and psychosocial health which was similar to the HRQOL of children with cancer on chemotherapy" [80-83].

Studies looking at quality of life in overweight and obese children taking part in lifestyle interventions did show that HRQOL improved even without significant weight loss among some participants [84, 85]. Hoffmeister et al. (2011) documented improved HRQOL in some children even without weight loss in a study with 1,916 children aged 8-16 in 48 treatment facilities for overweight and obese children and adolescents [85]. This may have been a result of an intervention, which included behavioral therapy.

To address obesity in adolescents, it is important to emphasize primary and secondary prevention in addition to treatment of the obesity. This could involve encouraging obese adolescents to make permanent lifestyle changes such as altering their approach to physical activity and diet. It is important to take into consideration the social and cultural factors that affect obesity when designing interventions to address obesity [86].

NEED TO EVALUATE HRQOL BY DEMOGRAPHIC VARIABLES AND WEIGHT STATUS

As stated, demographic variables, such as sex, ethnicity, and socioeconomic status, are associated with disparities in obesity prevalence. The evidence is inconclusive regarding how these demographic variables impact HRQOL in overweight and obese adolescents (Table 4). Some studies that assessed sex differences in HRQOL in overweight and obese adolescents have had conflicting results. Gopinath et al. (2013), in a study looking at BMI, weight status (overweight/obese) with HRQOL in 2,353 adolescents (mean age 12.7) and

52.6% females, White 54%, East Asian 20.6%, Southeast Asian 6.8%, Middle Eastern 8.8% and others 9.7%, reported that “adiposity in adolescent boys but not girls was associated with poorer quality of life” [87]. No sex differences were found in some studies that had used similar or identical measures to assess HRQOL [88] [89]. Modi et al. (2008) in a study using a parent proxy obesity specific QOL scale- ‘Sizing them up’, to assess HRQOL in 220 obese adolescents while controlling for other demographic variables, found no sex differences in the study population. Some studies did show that HRQOL scores were higher in adolescent boys than in adolescent females [90-92]. Fallon et al. (2005) examined the relationship between weight classification and HRQOL in 144 overweight and obese adolescents, mean age 14.3 with 47.2% White and 52.8% Blacks, and reported “an interaction between Black verses White race/ethnicity and weight class for only one HRQOL domain” as well as no sex difference in the HRQOL in this population. This study did not include a Latino population [93]. Our study, based in New Mexico, includes a high proportion of student who identify as Latino and the use of a standardized validated assessment tool (PedsQL 4.0 scale) which was not used in the study by Fallon and colleagues. Some studies showed that overweight and obese African American children noted “higher levels of physical comfort and self-esteem and less social and emotional impairment on HRQOL measures compared to White children” [94, 95]. Arif et al. (2006) examined HRQOL and weight status in different racial or ethnic groups of which 43.2% were Hispanic and 50.0% were white and found “no difference in the HRQOL between the Hispanics and whites

but the interactions between weight class and ethnicity was not reported" [96]. Wallander et al. (2009) also examined the association between weight status and HRQOL in 599 fifth grade children aged 10-13 years (African American 40%, Hispanic 34% and White 26%) controlling for other demographic variables found that there was no significant interaction between weight classification and race/ethnicity for HRQOL. Obese children reported significantly lower psychosocial but not physical HRQOL than those classified as non-overweight [97].

Krause et al. (2014) examined the relationship between overweight/obesity and HRQOL and its association with SES, and reported differences in the association between males and females [98]. SES is reported to have an effect on HRQOL variables [99] and lower SES is associated with a higher prevalence of overweight and obesity [5] therefore it is necessary to assess SES as a potential confounder of the relationship between HRQOL and weight status [100, 101].

Lower SES is associated with inadequate resources, which could make engaging in healthy lifestyle choices more difficult as well as access to affordable healthcare services. This could also be a source of stress to caregivers which may in turn impact the HRQOL of affected children and adolescents [102-105].

Table 4: Studies on HRQOL, Demographic variables and Weight status

References	Participants	Demographics	Setting of study	Study design	Data collected	Outcomes assessed	Result	Limitations
Gopinath B. et al. 2013	2353 participants in the cross section study and 1688 in the longitudinal study. Median age 12.7 years	Ethnicity (caucasian 54%, East Asian 20.6%, Southeast Asian 6.8%, Middle eastern 8.8%, other 9.7%) sex (females 52.6%),	Sydney childhood eye study (Sydney, Australia)	Cross sectional and longitudinal study	weight, height,waist circumference, percentage body mass fat, BMI	HRQOL using PedsQL	Adiposity (based on % body fat) in adolescent boys but not girls was associated with poorer QOL	1) HRQOL was assessed at 5years after initial presentation. 2) Participants may have underreported their health problem.
Michel G. et al. 2009	21,590 Children and adolescents Aged 8-18 years (mean 12.95)	Sex (females 52.6%, males 47.4%)	12 European countries participating in the KIDSCREEN survey	Cross sectional study	HRQOL using KIDSCREEN survey, age , sex	HRQOL	Girls' HRQOL declined more than boys' with increasing age.	it's a cross sectional study
Fallon EM., et al. 2005	110 overweight (62 Black, 48 White) and 34 non-overweight (14 Black, 20 White) adolescents Mean age 14.3 years	Sex (females 61.1%) SES (based on Holllingshead index), Ethnicity (White 47.2% , Black 52.8%)	Obesity treatment program- (Maryland, USA).	Cross sectional study	Height, weight, BMI, BMIz scores, QOL assessed using IWQOL, HRQOL, Child health questionnaire (parent report).	QOL	1). Compared with overweight white adolescents, blacks reported less impairment in QOL. 2). OWT whites reported greatest impairment on Social/Interpersonal, Self-Esteem, and Physical Appearance QOL 3). parents of overweight blacks reported the poorest General Health Perceptions scores regarding their children. 4). No sex diferences were noted using IWQOL or HRQOL scale.	Small sample size of non overweight adolescents. 2) sampling bias- OWT adolescents may have weight loss treatment

References	Participants	Demographics	Setting of study	Study design	Data collected	Outcomes assessed	Result	Limitations
Arif AA., Rohrer JE. 2006	5530 children Aged 3-18 years (mean age 10.6)	Sex, ethnicity (Hispanic 43.2% and Non-Hispanic 50.0% White),	Childhood health and diabetes survey from 109 Counties in West Texas	Cross sectional study	Height, weight, BMI, BMIz scores, parent report of hyperglycemic symptoms	HRQOL using KINDL(parent report	Male children exhibited better physical health as compared to the female children 2). No significant association between the Hispanic ethnicity and HRQOL was observed. 3). Those who reported mostly speaking Spanish, exhibited significantly lower overall HRQOL	Cross sectional study, participants with hyperglycemic symptoms/diabetes were included in the study
Wallander JL., et al. 2009	599 fifth grade public school students, aged 10-13years	Sex (females 54%), ethnicity (White 26%, African American 40%, Hispanics 34%), Educational level (< High school graduate 24%, college/associate degree 35%, professional degree 9%), and marital status of primary caregiver	University of Alabama (Birmingham), University of California (Los Angeles), University of Texas(Houston).	Cross sectional study	weight, height, BMI, Body satisfaction assessment, General self concept, QOL using PedsQL	QOL	There was no significant interaction between weight classification and race/ethnicity for QOL.	Small sample size, study participants were only 5th graders
Modi AC, et al. 2008	145 obese adolescents aged 11-18 years Mean age 15.3 years	Sex (females 68%), Ethnicity (White 52%, Black 45%, Hispanic 1%, Other 1%)	Cincinnati Childrens' Hospital medical center and University of Alabama.	Cross sectional study	weight, height, BMI, BMI z scores, QOL using PedsQL and IWQOL	QOL	1). Physical, emotional, and social scores of the PedsQL and the physical comfort and body esteem scores of the IWQOL-Kids were significantly higher for black compared to white adolescents with extreme obesity. 2). obese females reported lower HRQOL compared to obese males.	1). participants were only obese adolescents seeking weight management intervention. 2). Only 2 ethnic groups(white/black) were analysed.
Wallander JL, Kerbawy S, Toomey S, et al. 2013	4824 fifth grade public school students aged 10-12 years	Sex (females 49%) , ethnicity (White 23%, Black 30%, Hispanics 47%), Educational level of primary caregiver (< 9th grade 19%, High school graduate 21%, Bachelor degree 14%, >Bachelor degree 9%)	University of Alabama(Birmingham), University of California (Los Angeles), University of Texas(Houston).	Cross sectional study	weight, height, BMI, Body satisfaction assessment, General self concept, QOL using PedsQL	HRQOL	No significant disparities were found in the association between weight status and HRQOL among the three racial/ethnic groups or aong SES range.	Participants were 5th graders in 3 geographic regions . Study was cross sectional.

References	Participants	Demographics	Setting of study	Study design	Data collected	Outcomes assessed	Result	Limitations
Black WR., et al. 2014.	204 children aged 5-13.5 years (mean age 10.18 years)	Sex (females 53%), Ethnicity (African American 27%, White 25%, Hispanic 46%, other 2%),	Two Midwestern regional medical centers	Cross sectional study	Height, weight, BMI z scores, Weight related QOL measures (children self reported - 'Sizing me up' and parent proxy reported- 'Sizing them up')	HRQOL using weight related QOL measures	Males had higher emotional functioning scores. No ethnicity differences noted	1). Participants were enrolled in a pediatric obesity treatment program. 2) Measures of SES were not included in the study
Stern M., et al. 2007	100 overweight adolescents aged 11-18 years Mean age 14.3 years	Sex (females 59%), Ethnicity (African American 76%, White 18%, Hispanic 2%, Native American 1%, Asian 1% other 2%), SES (based on insurance information- Medicaid/uninsured 34%)	Urban medical center in Virginia	Cross sectional study	BMI percentile, self esteem inventory, food habits, perceptions of teasing, PedsQL	Psychosocial functioning assessed using PedsQl, Self esteem inventory and perceptions of teasing scales	No gender and race differences were found in the psychosocial measure	A cross sectional study based on self report which included only overweight treatment seeking adolescents
Modi AC,Zeller MH. 2008	220 obese adolescents Mean age 11.6 years	Ethnicity : (White 42%, African American 53%, Other 4%, Native American 1%) Sex (females 68%)	Cincinnati Childrens' Hospital	Cross sectional study	Height, weight, BMI, BMIz scores	HRQOL using PedsQL, Sizing Them Up (a parent proxy obesity specific QOL scale) and IWQOL (impact of weight on QOL- a weight specific HRQOL measure).	No gender differences were found using Sizing Them Up scale but parents of African American youth reported better total score, emotional and physical functioning compared to parents of White youth.	Population was treatment seeking adolescents, ethnicity was assessed as 2 groups only (white and African American)
Schwimmer JB. et al. 2003	106 obese children and adolescents, aged 5-18years (mean age 12.1years), 106 cancer patients 401 healthy participants	Sex (females 46%), Ethnicity (White 26.4%, Hispanic 59.4%, Black 7.5%, Asian 0.9%, Other 5.7%), SES (based on Hollingshead index)	Childrens' Hospital and Health center in San Diego, California.	Cross sectional study	Height, weight, BMI,BMIz scores, History of comorbid symptoms	HRQOL using child self report and parent proxy report(PedsQl	1) Severely obese children and adolescents had lower HRQOL compared to healthy group 2) Severely obese group had HRQOL similar to children/adolescents with cancer. 3) In the obese group, no significant differences in QOL scores by sex and ethnicity	Population was treatment seeking children and adolescents, cross sectional study

References	Participants	Demographics	Setting of study	Study design	Data collected	Outcomes assessed	Result	Limitations
Kunkel N. et al. 2009	467 adolescents, aged 15-18years (mean age 15.9yrs)	Sex (males 37%), self-refered skin color (White 71.5%, Indian/black/mixed 28.5%) Family head schooling (illiterate 2.8%, 4yrs of school 10%, 8yrs of school 28.3%, >9yrs of school 56.6%) , Socioeconomic status(based on mean per capita income- $424.15).	Students in public schools in Florianopolis, Southern Brazil	Cross sectional study	Height, weight,BMI, HRQOL	HRQOL using PedsQL	1) Adolescents with excess weight had lower HRQOL. 2) Female adolescents had lower quality of life scores. 3) Based on skin color, parents reported lower HRQOL in black amd mixed colored children.	Height of participants were based on self report. 2) Socioeconomic conditions were not controlled for.
Keating CL. et al. 2011	2890 students-mean age 14.6yrs	Sex (males 56.2%), SES based on Socio-economic index for areas (SEIFA)- <25th SES quartile 24.7%, 25th-<50th 16%, 50th-75th 38.3%, >75th 19.8%)	Pacific Obesity prevention in communities project, Australia	Cross sectional study	Height, weight,BMI, HRQOL	HRQOL using PedsQL	1) overweight and obese females reported lower HRQOL scores compared to the overweight and obese boys .	some groups were over represented in the study- adolescents who lived in higher SES areas, more boys, adolescents from regional areas and centers
Bonsergent E. et al. 2012	5226 adolescents aged 14-18yrs (mean age 15.7)	Sex (females 55%), parental occupation (Employed 48%, Intermediate jobs 20.2%, unemployed 9.4%, Executives 14.3%) , family income (low 6.4%, moderate 34.2%, high 59.3%)	PRALIMAP trial in 24 high schools in France	Cross sectional study	Height, weight,HRQOL,BMI,	HRQOL using Duke Health profile for adolescents	1) All HRQOL scores were higher for boys than girls. 2) The less favourable the socioeconomic parameters(social and professional class, parental occupation, perception of family income), the lower the HRQOL scores. 3) The higher the BMI, the lower the mental HRQoL score in girls, but not in boys	Cross sectional study

Understanding the relationship between HRQOL and demographic variables could contribute to the identification of more focused interventions to improve HRQOL in overweight and obese adolescents. This study evaluated the association of demographic variables with the HRQOL in non-overweight, overweight and obese adolescents in New Mexico high schools through the analysis of baseline data from the ACTION PAC (Adolescents Committed to Improvement of Nutritional and Physical Activity) project. Due to inconclusive evidence, we examined the relationship between demographic variables, weight status and HRQOL in adolescents participating in ACTION PAC. To accomplish this, the following aims were proposed:

Aim 1: To examine cross-sectional differences in HRQOL in New Mexico adolescents participating in ACTION PAC by weight status. We hypothesize that self-reported HRQOL will be lower in overweight and obese adolescents compared to non-overweight adolescents.

Aim 2: To determine the cross-sectional relationship between demographic variables, weight status and HRQOL in New Mexico adolescents. We hypothesize that demographic variables will affect the relationship between weight categories and self-reported physical and psychosocial functioning among adolescents.

LITERATURE SEARCH STRATEGY

For the literature search, I queried the databases PubMed, Web of Knowledge and Academic Search Complete. PubMed is a resource for citations and abstracts of biomedical literature from MEDLINE, life science journals and online books. Web of Knowledge is a resource for information in the sciences, social sciences, arts and humanities; while Academic Search Complete is a comprehensive scholarly, multi-disciplinary full-text database designed specifically for academic institutions.

The first search was with the PubMed database, which I accessed through the University of New Mexico HSLIC homepage (http://hsc.unm.edu/library). I selected the "PubMed" tab in the quick search section. Next, I selected the link to the MeSH database and entered "Quality of life" as a MeSH term. I then clicked on "add term to search builder". Next, I typed "Obesity" in the MeSH term field and then clicked on "Obesity". I then clicked on "add term to search builder". I typed "Demographic factors" in MeSH term field and then clicked on "add term to search builder". Next, I clicked on "Search PubMed." Limiting my search to last 10 years, humans, English, and ages birth to 18 years, the search returned 170 results.

The next search was also with the PubMed database accessed through the University of New Mexico HSLIC homepage (http://hsc.unm.edu/library). I selected the "PubMed" tab in the quick search section. Next, I selected the link to the MeSH database and entered "Quality of life" as a MeSH term. I then clicked

on “Add term to search builder”. Next, I typed “Obesity” in the MeSH term field and then clicked on Pediatric Obesity which I also added to the search builder. Then I clicked on “Search PubMed” and in limiting my search to humans, the search returned 52 results.

My third search was through the Web of Science database which I accessed through the University of New Mexico HSLIC homepage (http://hsc.unm.edu/library). I clicked on the database tab and selected “W”, then I chose the Web of Knowledge link. Next I entered “Health-related quality of life” in the Topic search field. In the second search field, I entered “Weight status in adolescents” and in a third search field, I entered “Demographic variables”. I limited my search to “topic, all years and English”. My search returned 14 results.

The last search involved the Academic Search Complete Database accessed through the University of New Mexico HSLIC homepage (http://hsc.unm.edu/library). I selected the database tab, clicked on “A” and then chose the Academic Search Complete link. Next I entered “The relationship between demographic factors and health-related quality of life in overweight and obese adolescents” in search bar. I limited my search to “find all my search terms, full text, scholarly (peer reviewed journals), PDF full text, English and publication years from 2000-2016” and the search returned 1 result.

METHODOLOGY

STUDY DESIGN AND SETTING

A cross-sectional secondary analysis was completed utilizing baseline data from the ACTION PAC project. The ACTION PAC project, a cluster randomized controlled trial, is a novel National Institutes of Health (NIH) funded research study to investigate the efficacy of motivational interviewing approaches for overweight and obesity prevention and treatment in eight New Mexico high schools (four from Albuquerque-area schools in Bernalillo County and four from Dona Ana and Otero Counties) that have school-based health centers (SBHCs). SBHCs provide healthcare services to insured and uninsured students at school thus making healthcare affordable and accessible to this population since they spend most of their time in school. Essential health care services are also available to the adolescents at this stage of their development and decision making through the SBHCs [106, 107].

A total of 991 participants in the 9th and 10th grades were enrolled and will be followed for two years. Schools were randomized to either the intervention or the comparison group. To limit school level differences, high schools that were included in the study shared the following characteristics: 1) schools with functioning SBHCs, 2) schools with at least 700 enrolled students, 3) schools with at least 40% Hispanic youth, 4) schools with at least one outdoor field, one gymnasium and physical activity opportunities and 5) schools with at least one cafeteria, vending machines and foods brought into school from outside vendors.

Written assent from the students as well as written consent (available in Spanish and English) from the parents or guardians were obtained prior to the students' participation in ACTION PAC. Institutional Review Board approval was obtained from the University of New Mexico Human Research Protection office (HRRC #12-614). All participating schools' districts also reviewed and approved the study protocol.

PARTICIPANTS

Nine hundred and ninety one adolescents in the 9th or 10th grade were recruited through school registration events, through the SBHCs and through class presentations. The participants' caregivers completed a health history questionnaire that included questions about personal and family history of medical conditions and current medications. Health histories were reviewed by phone with all parents or guardians of participating students by trained research staff. Exclusion criteria for the ACTION PAC study included: 1) a diagnosis of type 1 or 2 diabetes; 2) blood pressure in the range of stage 2 hypertension; 3) current use of oral or injectable corticosteroids, antipsychotics and/or medications for the treatment of diabetes, hypertension and/or hyperlipidemia; 4) inability to perform moderate to vigorous physical activity or not being ambulatory; 5) a score of 20 or more on the EAT-26 eating disorder risk screening questionnaire; 6) developmental disorders that affect weight or the ability to understand the study procedures or counseling and 7) pregnancy. Participants were compensated with a $20 gift card at each data collection period.

MEASUREMENTS

ANTHROPOMETRICS

Weight and height were measured by trained and standardized research assistants. Weight was measured twice on a digital scale (SECA#770, Chino, CA, USA) with the participant not wearing shoes and in light clothing. If the two readings differed by >0.5 kilogram, a third reading was taken and the mean value for the two closest readings was used for analysis. Height of participants without shoes was measured twice with a portable stadiometer (SECA #213, Chino, CA, USA). If the two readings differed by >0.1 centimeter, a third reading was taken and the mean value for the two closest readings was used for analysis. Both weight and height were measured according to procedures established by Lohman and colleagues and the National Health and Nutrition examination Survey (NHANES) Anthropometric Procedures Manuel [108]. Body mass index (BMI) was calculated in kg/m² per standard technique, then age-adjusted BMI percentiles and Z-scores were generated from the calculated BMI using the CDC age- and sex-specific LMS BMI-for-age charts for ages 2-20 years [109]. Students with BMI percentile of ≤85% for age and sex were considered to be non-overweight, with BMI 85% to 94.9% to be overweight and BMI 95%-99.9% to be obese.

HEALTH RELATED QUALITY OF LIFE

The Health Related Quality Of Life (HRQOL) of participants was assessed using the Pediatric Quality of Life Inventory Version 4.0 (PedsQL 4.0). This instrument,

originally developed by Dr. Varni and colleagues, used a pediatric cancer database, but it has been developed further to include “additional constructs [and] items with a more sensitive scaling range” [110]. The PedsQL 4.0 assesses adolescent HRQOL with self-report. There are 23 items with a 5-point Likert scale for the extent to which each item has been a problem during the past month (0=never a problem, 1=almost never a problem, 2=sometimes a problem, 3=often a problem and 4= almost always a problem). These items are then reverse scored on a scale of 0 to 100 (0=100, 1=75, 2=50, 3= 25 and 4= 0). A mean score is computed for psychosocial health (comprising emotional, social and school functioning scores) and physical health. The responses to all questions are averaged to provide a total HRQOL score [111]. A higher score reflects a better HRQOL. In reliability and validity tests, the PedsQL 4.0 has consistently had high reliability scores (Cronbach’s alpha = 0.71-0.89) and has been able to distinguish between healthy children and those with chronic diseases [112].

DEMOGRAPHIC CHARACTERISTICS

The demographic characteristics of participants and their parents/guardians were obtained from a demographic questionnaire (see Table 5) completed by each participant’s parent or caregiver. Demographic information included the age, sex, ethnicity and socioeconomic status based on caregiver’s household income.

Table 5: Demographic Questionnaire

Pt ID……. Date ……..	
Is your teen	O Male O Female
Information About You (parent/guardian filling the survey)	
What is your ethnicity/Race? Check all that apply	O Hispanic or Latino O American Indian or Alaska Native O White or Anglo O Asian O Black or African American O Other (specify) O Native Hawaiian or other Pacific Islander
What is your family's yearly household income?	O < $10,000 O $10,000-$19,999 O $20,000-$29,999 O $30,000-$39,999 O $40,000-$49,999 O $50,000-$74,999 O $75,000-$99,999 O > $100,000

DATA ANALYSIS

Based on previous studies [113], we predicted measures of HRQOL to have a standard deviation of 15. For a desired power of 80% and a type 1 error rate of 0.05, we estimated a sample size of 931 to be able to detect differences in HRQOL means of 2.1 points between groups.

Descriptive statistics were calculated to describe the weight status, age, sex, ethnicity, and HRQOL scores of the participants. We conducted analysis of

variance and chi-square tests to examine if demographic variables varied by weight status and if HRQOL varied by weight status.

Multilevel, multivariable linear regression models were used to analyze associations between weight status, demographic variables and the HRQOL scores. Due to the cluster design of the ACTION PAC project, all models were adjusted for clustering of schools. Level 1 included participants within the schools while level 2 included the participating schools in the different participating regions in New Mexico. This allowed for comparison of the adolescents between schools and within schools. Intraclass correlation coefficients were estimated to show variability within schools. Using multilevel modelling was also helpful because datasets did not have to be equally balanced for each school. Independent variables were the demographic variables (sex, ethnicity and socioeconomic status as defined by household income) and weight status based on BMI percentile. The dependent variables were the HRQOL scores as continuous measures. P-values < 0.05 was considered statistically significant. STATA version 14.0 (StataCorp., College Station, TX, USA) and SAS version 9.4 (SAS institute, Cary, NC, USA) were used for all analyses.

RESULTS

Intraclass correlation by HRQOL scale scores was not significantly different from zero thus students within schools were not very alike. Table 6 shows that the intraclass correlations by HRQOL are small (0-0.0186). Similarities between individuals within a cluster are considered substantial when the intraclass correlation is > 0.1. For example, students within a school in a certain neighborhood might be expected to have similar SES compared with students in a school in a different neighborhood. Clustering is distinct when objects in a group are similar and there are large differences between groups [114].

Table 6: Intraclass correlation by HRQOL scale

	Intraclass correlation (95% CL)
Total Score	0.0068 (0.0008 – 0.0578)
Physical Health Score	0
Psychosocial Health Score	0.0090 (0.0030 – 0.0014)
Emotional Functioning	0
Social Functioning	0.0033 (0.0001 – 0.0990)
School Functioning	0.0186 (0.0046 – 0.0724)

Table 7 presents the demographic characteristics of study participants by weight status. A total of 991 participants enrolled in the study, with a mean BMI percentile of 79.4. Distribution of BMI across weight groups were as follows: 61.6% non-overweight (mean BMI percentile = 51.1), 19.8% overweight (mean

BMI percentile = 90.6) and 18.7% obese (mean BMI percentile = 97.7). Age range was from 13.4 years to 18.5 years with an average of 15.3 years. A majority of participants were females (54.8%) and Hispanic (82.9%). Socioeconomic status was assessed based on yearly household income; 41.6% of participants were from households with yearly income of less than $20,000.

Table 7: Demographic characteristics of participants by weight status

Characteristics	Total** (N=991)	Non-Overweight (N=610)	Overweight (N=196)	Obese (N=185)	p-value*
Age in years, mean (SD)	15.3 (0.7)	15.3 (0.7)	15.4 (0.7)	15.3 (0.6)	0.72
BMI percentile, mean (SD)	79.4 (11.8)	51.1 (24.1)	90.6 (2.9)	97.7 (1.3)	
Sex, N (%)					0.02
Female	543 (54.8%)	334 (54.8%)	121 (61.7%)	88 (47.6%)	
Male	448 (45.2%)	276 (45.2%)	75 (38.3%)	97 (52.4%)	
Race/Ethnicity, N (%)					0.78
Hispanic	820 (82.9%)	501 (82.3%)	164 (83.7%)	155 (84.2%)	
Non-Hispanic	169 (17.1%)	108 (17.7%)	32 (16.3%)	29 (15.8%)	
Household Income/yr					0.04
Less than $20,000	398 (41.6%)	238 (40.5%)	71 (37.6%)	89 (49.4%)	
$20,000 to $39,999	289 (30.2%)	175 (29.8%)	58 (30.7%)	56 (31.1%)	
$40,000 or more	269 (28.1%)	174 (29.6%)	60 (31.7%)	35 (19.4%)	

*Chi-square for categorical, ANOVA for continuous

**Total counts may not sum to overall N due to missing data

A summary of the HRQOL scores by weight categories is represented in Table 8. Higher scores in all domains of the HRQOL measures were found among the non-overweight and overweight study participants compared to the obese group, except in school functioning where the obese participants had a slightly higher HRQOL score compared to the overweight group. The observed differences between groups were significant ($p<0.05$) in all domains except physical health score ($p= 0.11$) and emotional functioning score ($p= 0.22$).

Table 8: Quality of life scores by weight categories

	Non – Overweight (N=610)	Overweight (N=196)	Obese (N=185)	p-value*
Total Score, mean (SD)	80.2 (11.6)	78.8 (11.1)	77.5 (12.9)	0.016
Physical Health	85.3 (12.1)	84.8 (12.3)	83.1 (12.8)	0.11
Psychosocial Health	77.5 (13.2)	75.6 (12.6)	74.5 (14.5)	0.016
Emotional Functioning	75.2 (18.9)	74.6 (18.6)	72.4 (20.2)	0.22
Social Functioning	86.7 (13.8)	85.9 (13.1)	83.0 (16.6)	0.007
School Functioning	70.6 (16.7)	66.5 (16.7)	68.2 (17.2)	0.007

*ANOVA

Examination of average HRQOL scores by various demographic variables (Table 9), shows that males have significantly higher average HRQOL scores compared to the females in all domains, except in school functioning were the difference was not statistically significant ($p= 0.45$).

The Hispanic population had higher average HRQOL scores in all domains except in the physical health score compared to the non-Hispanic population. This difference was statistically significant only for the psychosocial and social functioning scores ($p< 0.05$).

There were variable, non-significant differences in average HRQOL scores across yearly household income categories. A household income of ≥ $40,000 showed higher HRQOL in all domains except physical score and social functioning scores. Household income $20,000 - $39,999 had higher score in physical health, while income > $20,000 had the highest social functioning score.

There were the same trends in the relationship between weight status and HRQOL for both males and females, although the observed differences between groups were only significant for females (Tables 10 and 11). Obese males had lower average HRQOL scores, though not statistically significant, compared to the overweight and non-overweight males in all domains, except in school functioning. Obese males had a higher HRQOL score compared to the overweight males in school functioning HRQOL scores. A similar trend was seen among the females with higher HRQOL scores recorded among the non-overweight females compared to the overweight and obese in all domains. These were significant in all domains except physical health and emotional functioning scores. Obese females had a higher HRQOL score in school functioning compared to the overweight group.

Table 9: Demographic characteristics of participants and quality of life

Characteristics	Sex		Ethnicity		Household income/year		
	Male	Female	Hispanic	Non-Hispanic	<$20,000	$20,000 - $39,999	>$40,000
Total score (mean, SD)	81.9 (11.2)	77.4 (11.9)	79.7 (11.9)	78.0 (11.1)	79.3 (12.5)	79.3 (11.4)	79.6 (11.2)
p value	<0.0001		0.090		0.93		
Physical score (mean, SD)	88.1 (10.8)	82.0 (12.7)	84.7 (12.5)	84.8 (11.4)	84.2 (13.4)	85.3 (11.6)	84.9 (11.3)
p value	<0.0001		0.94		0.52		
Psychosocial score (mean, SD)	78.6 (13.1)	74.9 (13.5)	77.0 (13.5)	74.3 (13.0)	76.7 (14.0)	76.1 (13.0)	76.9 (13.0)
p value	<0.0001		0.02		0.77		
Emotional score (mean, SD)	78.9 (17.7)	70.9 (19.5)	75.0 (19.2)	72.6 (18.7)	74.3 (20.1)	74.4 (18.5)	75.1 (18.5)
p value	<0.0001		0.14		0.88		
Social score (mean, SD)	87.1 (13.7)	84.9 (14.7)	86.5 (14.0)	82.7 (15.4)	86.4 (14.8)	85.4 (14.1)	85.8 (14.0)
p value	0.01		0.002		0.65		
School score (mean, SD)	69.8 (17.0)	69.0 (16.7)	69.7 (16.9)	68.0 (16.6)	69.6 (17.8)	68.7 (16.0)	69.7 (16.4)
p value	0.45		0.24		0.73		

Table 10: Quality of life scores for males by weight categories

	Non – Overweight (N=275)	Overweight (N=75)	Obese (N=97)	p value
Total Score, mean (SD)	82.6 (11.4)	81.4 (9.4)	80.2 (11.8)	0.17
Physical Health	88.4 (10.7)	88.9 (10.0)	86.6 (11.5)	0.28
Psychosocial Health	79.5 (13.3)	77.4 (11.0)	76.8 (13.6)	0.15
Emotional Functioning	80.1 (17.3)	77.3 (19.5)	76.8 (17.1)	0.20
Social Functioning	87.7 (13.9)	87.8 (11.4)	84.8 (14.8)	0.18
School Functioning	70.9 (17.4)	67.1 (14.6)	68.9 (17.4)	0.20

Table 11: Quality of life scores for females by weight categories

	Non – Overweight (N=334)	Overweight (N=121)	Obese (N=88)	p value
Total Score, mean (SD)	78.2 (11.3)	77.2 (11.8)	74.5 (13.5)	0.03
Physical Health	82.6 (12.5)	82.2 (12.9)	79.2 (13.1)	0.08
Psychosocial Health	75.8 (12.9)	74.5 (13.4)	71.9 (15.1)	0.05
Emotional Functioning	71.1 (19.2)	73.0 (18.0)	67.5 (22.2)	0.13
Social Functioning	85.9 (13.7)	84.8 (14.0)	80.9 (18.2)	0.02
School Functioning	70.4 (16.1)	66.2 (17.9)	67.4 (17.1)	0.03

Hispanic adolescents who were obese had lower average HRQOL scores compared to the non-overweight and overweight group, except in school functioning where the obese group had a higher score compared to the

overweight group (Table 12). This was statistically significant in the total scores, psychosocial health scores, social and school functioning scores (p value < 0.05).

Table 12: Quality of life scores for Hispanic youth by weight categories

	Non – Overweight (N=500)	Overweight (N=164)	Obese (N=155)	p value
Total Score, mean (SD)	80.5 (11.5)	79.2 (11.4)	77.7 (13.5)	0.03
Physical Health	85.3 (12.1)	84.9 (12.7)	83.0 (13.3)	0.13
Psychosocial Health	77.9 (13.1)	76.1 (12.8)	74.9 (15.0)	0.03
Emotional Functioning	75.5 (18.9)	74.9 (18.6)	73.1 (20.8)	0.39
Social Functioning	87.4 (13.4)	86.5 (12.9)	83.6 (16.4)	0.01
School Functioning	71.0 (16.5)	67.1 (17.2)	68.1 (17.8)	0.02

Among the non-Hispanic adolescents (Table 13), a similar trend was noted; non-overweight adolescents had higher HRQOL scores compared to the overweight and obese group in all HRQOL domains. The obese group had a higher school functioning score compared to the overweight group. These were not significantly different among the BMI groups.

Table 13: Quality of life scores for Non-Hispanic youth by weight categories

	Non – Overweight (N=108)	Overweight (N=32)	Obese (N=29)	p value
Total Score, mean (SD)	78.8 (12.0)	76.8 (9.3)	76.4 (9.6)	0.48
Physical Health	85.2 (12.2)	84.2 (9.9)	84.1 (9.7)	0.84
Psychosocial Health	75.3 (13.8)	72.8 (11.3)	72.3 (11.8)	0.41
Emotional Functioning	73.3 (19.1)	73.1 (19.4)	69.1 (16.7)	0.56
Social Functioning	83.5 (15.2)	82.9 (13.6)	79.6 (17.8)	0.48
School Functioning	69.1 (17.8)	63.8 (13.3)	68.4 (14.5)	0.28

The observed relationships between HRQOL and weight status were similar to the overall observed patterns in the lowest income group, but less clear in higher income groups. Non-overweight adolescents in households with yearly income of less than $20,000 had higher average HRQOL scores in all domains compared to the overweight and obese adolescents (Table 14). This was significant in all domains except in physical health and school functioning. Adolescents in households with yearly income of $20,000 to $39,999 showed higher HRQOL scores among the non-overweight in emotional and school functioning scores compared to the other groups. Higher scores were noted among the obese group in total score, physical health and psychosocial health scores. The overweight group had higher social functioning scores compared to the other groups (Table 15). These differences were not statistically significant except in school

functioning scores. Higher HRQOL scores were seen among overweight adolescents in households with yearly income of greater than $40,000 in all domains of the HRQOL measures except in school functioning, though none were statistically significant. Non-overweight adolescents recorded a higher HRQOL score in school functioning (Table 16).

Table 14: Quality of life scores for youth in households with income less than $20,000 by weight categories

	Non – Overweight (N=238)	Overweight (N=71)	Obese (N=89)	p value
Total Score, mean (SD)	80.8 (12.2)	78.6 (11.9)	76.0 (13.2)	0.01
Physical Health	85.3 (13.1)	84.0 (13.5)	81.6 (13.8)	0.09
Psychosocial Health	78.5 (13.5)	75.6 (13.2)	73.0 (15.0)	0.01
Emotional Functioning	76.0 (19.7)	74.9 (18.0)	69.4 (22.3)	0.03
Social Functioning	88.2 (13.4)	85.8 (14.0)	82.0 (17.9)	0.00
School Functioning	71.2 (17.8)	67.0 (17.9)	67.6 (17.4)	0.11

Table 15: Quality of life scores for youth in households with income between $20,000 and $39,999 by weight categories

	Non – Overweight (N=174)	Overweight (N=58)	Obese (N=56)	p value
Total Score, mean (SD)	79.6 (11.5)	78.0 (10.7)	79.8 (11.8)	0.61
Physical Health	76.6 (13.2)	85.3 (11.2)	85.4 (10.9)	0.99
Psychosocial Health	74.5 (18.6)	74.1 (12.1)	76.8 (13.4)	0.42

Emotional Functioning	85.4 (14.8)	73.3 (18.2)	75.4 (19.1)	0.83
Social Functioning	69.9 (15.8)	85.7 (12.5)	84.8 (13.8)	0.93
School Functioning	79.6 (11.5)	63.4 (15.5)	70.3 (16.1)	0.02

Table 16: Quality of life scores for youth in household with income of $40,000 or more by weight categories

	Non – Overweight (N=174)	Overweight (N=60)	Obese (N=35)	p value
Total Score, mean (SD)	79.7 (11.0)	80.5 (10.0)	78.0 (13.9)	0.58
Physical Health	85.0 (11.0)	85.5 (11.3)	83.2 (12.9)	0.61
Psychosocial Health	76.9 (13.0)	77.8 (11.7)	75.1 (15.3)	0.64
Emotional Functioning	74.5 (18.5)	76.7 (19.8)	75.1 (16.3)	0.73
Social Functioning	86.0 (13.5)	86.8 (12.8)	83.1 (18.2)	0.45
School Functioning	70.2 (16.3)	69.8 (15.1)	67.3 (18.7)	0.64

Analysis showed there was no statistically significant interaction between BMI categories with demographic variables; therefore no interaction terms were included in the models. The results of the multilevel, multivariable linear regression models are included in Table 17.

Table 17: Results of multilevel, multivariable linear regression models examining the relationship between weight status, sex, household income and Hispanic ethnicity and HRQOL

	Physical	Emotional	Social	School	Psychosocial	Total
Overall model p-value	<0.001	<0.001	0.001	0.14	<0.001	<0.001
Intercept	82.36 (1.39)***	68.74 (2.05)***	83.73 (1.57)***	69.25 (2.47)	73. 96 (1.61)***	76.87 (1.42)***
Weight status						
BMI %tile <85th	ref	ref	ref	ref	ref	ref
BMI %time 85th-94.9	0.00 (0.99)	0.04 (1.57)	-0.60 (1.19)	-3.69 (1.39)	-1.42 (1.10)	-0.90 (0.96)
BMI %tile <=95th	-2.54 (1.02)*	-3.36 (1.60)*	-3.97 (1.22)**	-2.02 (1.42)	-3.13 (1.13)**	-2.91 (0.98)**
Sex						
Female	ref	ref	ref	ref	ref	ref
Male	6.23 (0.77)***	8.39 (1.22)***	2.57 (0.93)**	0.68 (1.08)	3.89 (0.86)***	4.68 (0.75)***
Income						
<$20,000	ref	ref	ref	ref	ref	ref
$20,000 to $39,999	0.74 (0.92)	-0.22 (1.45)	-1.12 (1.10)	-1.07 (1.29)	-0.80 (1.02)	-0.29 (0.89)
$40,000 and above	0.07 (0.97)	0.84 (1.52)	-0.44 (1.16)	-0.30 (1.36)	0.44 (1.08)	0.01 (0.94)
Hispanic						
No	ref	ref	ref	ref	ref	ref
Yes	-0.25 (1.15)	2.79 (1.81)	2.73 (1.37)*	1.48 (1.61)	2.25 (1.28)	1.41 (1.11)

ref = reference group
p-value *<0.05, **<0.01, ***<0.001

In multilevel, multivariable linear regression models including weight status, sex, household income and Hispanic ethnicity (Table 17), BMI ≥95th percentile was significantly associated with poorer reported physical, emotional, social and overall psychosocial functioning, compared to BMI <85th percentile, and male sex was significantly associated with better reported physical, emotional, social and overall psychosocial functioning, compared to female sex. Income was not significantly associated with any of the HRQOL outcomes in the multivariable models while Hispanic ethnicity was positively associated with social and overall psychosocial functioning.

DISCUSSION

In this cross-sectional study, obese adolescents were found to have a lower HRQOL compared to non-overweight adolescents irrespective of their sex, ethnicity and socioeconomic status. In addition, we found that adolescent males have a higher HRQOL compared to adolescent females irrespective of their weight status, household income and ethnicity.

HRQOL

There was a statistically significant impairment in the total, psychosocial health, social, physical and school functioning scores among the obese adolescents compared to the non-overweight group. Low physical HRQOL scores in obese adolescent may be due to lack of energy needed to engage in active physical activities [70]. In the validated PedsQL 4.0 scoring scale for assessing HRQOL, questions assessing school functioning include; 'I miss school because of not feeling well' and 'I miss school to go to the doctor or hospital'. Obese adolescents may be at a higher risk of having more obesity related complications that may require attention thus likely leading to more school days absenteeism. A study on overweight/obesity and school attendance found that obese children had more missed days of school compared to normal weight children [115]. In each of the weight categories, social functioning had the highest HRQOL score compared to the other domains. Social networking and peer acceptance plays a significant role in the social behavior and development of adolescents. This factor may influence the social functioning HRQOL scores of adolescents.

SEX

In our study, males had significantly higher HRQOL than females in all domains except school, independent of weight status, household income and ethnicity. Studies examining the relationship between sex, weight status and HRQOL have shown that females with excess weight have a lower HRQOL [116-118]. Our study also showed a similar effect of obese females having a significantly lower HRQOL score compared to non-overweight and overweight females in our population. In contrast to the study by Gopinath et al. (2013), we found that adiposity in adolescent females and not males was significantly associated with lower HRQOL, although obese males had a lower HRQOL compared to non-overweight and overweight males in various domains in our study, and the lack of significance could be a power issue. Body image issues with associated lower self-esteem may be more common among adolescent females. Based on a youth risk behavior survey report, “female students were more than twice as likely as male students to consider themselves to be “too fat” [119]. These factors could impact HRQOL scores among females which may be worse among obese adolescent females. Bisegger et al. (2005) notes that a difference in HRQOL between females and males could possibly be due to hormonal effects during puberty as well as on societal demands and influences [120].

RACE AND ETHNICITY

Among the ethnic groups (Hispanic and Non-Hispanic) analyzed, similar trend of lower HRQOL scores were seen among the obese group verses the overweight

and non-overweight groups. There was a statistically significant positive effect noted in psychosocial health and social functioning for the Hispanic compared to non-Hispanic participants. Factors such as family support and high ethnic density may have played a role in this finding.

SOCIOECONOMIC STATUS

Although there were some variations in HRQOL scores noted among $20,000 - $39,999 and >$40,000 socioeconomic status groups as assessed based on yearly household income, these were not statistically significant. This study showed statistically significant differences in the psychosocial, emotional and social domains of the HRQOL measures in the group with household income <$20,000 yearly which represents families living near the poverty line (<$24,300/year for a family of four). As noted by Kinge et al. (2010), lower HRQOL scores have been reported among overweight/obese people in lower SES group compared to non-overweight in same SES group as well as those in higher SES group [121].

Assessing the relationship between weight status and HRQOL as well as the association of various demographic variables in the adolescent population is very important. Apart from the physical and psychological changes which are occurring in this population, lifestyle decisions and habits made during this period of development tend to be very influential as an adolescent matures into adulthood. Bisegger et al. (2005) notes that, as adolescents are faced with various challenges, they tend to develop their own values and norms [120].

STRENGTHS

This study, which is the first of its kind to be carried out in New Mexico, contributes to the understanding of how demographic variables impact the relationship between weight status and HRQOL. The study had a large sample size, and the questionnaire response rate of participants in the study was high.

LIMITATIONS

The study is a cross-sectional design study in which we cannot directly assess temporal or causal relationships between variables. Participants in the study were recruited through self-selection. This may be a form of bias since relatively healthier or more motivated individuals may be more interested in participating in the study. Another selection bias may have been as a result of one of the enrollment criteria of choosing which schools could participate in the study. One criteria was that the participating schools had to have at least 40% Hispanic students enrolled in the school. This may limit the variability in the ethnic groups which is one of the demographic variables analyzed in this study. This factor may also impact the generalizability of this study. The use of only public schools with a SBHC may impact the generalizability of this study. Students attending schools with a SBHC are at a greater advantage of having healthcare services readily available and accessible, but are more likely to be low income, as services are provided in areas where they are needed most. Informational bias such as recall bias may be a limitation in this study. Recall bias is a result of remembering inaccurately desired information in a study. Although the PedsQL 4.0 scoring

scale which assesses HRQOL is a validated tool, there may be recall bias as participants were required to self-report how much various factors were a problem for them within a one month period. Recall bias may be minimal if participants were required to keep a daily or weekly log. Reporting on household income which was an assessment of socioeconomic status – a variable analyzed in the study, may have been a source of informational bias. Household income reported may not be entirely accurate as most individuals may not be very comfortable giving out information about their yearly household income.

IMPLICATIONS

This study, which showed a lower HRQOL in obese adolescents compared to the non-overweight adolescents, may have some clinical implications. In addressing adolescent obesity, management should not be confined to the disease process only but attention should be paid to the physical and psychosocial wellbeing of the adolescents. Interventions to improve an adolescent's weight status without necessarily attaining a normal weight could improve the HRQOL status of the adolescent which could be very beneficial. According to Fontaine et al. (2001), having discussions on the relationship between obesity and HRQOL with the caregivers and patients could help plan specific interventions for the patient [122].This study may also be informative in guiding the development of prevention strategies to address adolescent obesity with regards to health-related quality of life and demographic variables such as sex.

CONCLUSION

In this study, the findings indicate that obese adolescents have a lower HRQOL compared to non-overweight adolescents irrespective of their sex, ethnicity and socioeconomic status. Further, adolescent males have a higher HRQOL compared to adolescent females irrespective of their weight status, household income and ethnicity.

FUTURE DIRECTION

Determining the relationship between weight status, demographic variables and HRQOL in adolescents could stimulate the development of interventions geared towards improving HRQOL in overweight and obese adolescents. It would also inform the need for healthcare providers to assess for HRQOL in overweight and obese adolescents while encouraging lifestyle changes such as increasing physical activity. Lastly, healthcare providers should continue to be advocates for these adolescents by working in collaboration with the patients, caregivers, communities and policy makers.

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