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Assessment of adolescent health conditions in the United Arab Emirates: roles of parental perceptions of the micro and meso built environmental variables

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Introduction: Parent perception and willingness to let their children walk in the arid region of the UAE are impacted by the complexity of environmental factors and children's own engagement in physical activity. This study, therefore, investigates responses from parents' perception of the microenvironment, such as sidewalk, streets, traffic, safety, and appeal of the built environment, and meso-environmental factors such as walkability index, traffic exposure at school and residences, and distance to school on the health measured as underweight, normal weight, overweight, and obesity levels of children.

Methods: School-going children aged 14 to 20 years from seven schools in Al Ain were selected for this study. A survey adapted from the Home Environment Survey (HES), based on the socio-ecological model of physical activity, was administered both in Arabic and English. The outcomes of the health condition measured in four categories based on the BMI were analyzed using multinomial logistic regression. The normal health condition was selected as the base outcome category, with underweight, overweight, and obese, and other outcomes assessed for the study.

Results: Gender and physical activity scores predict the obese and underweight categories of the health condition of the adolescents, while age predicts the overweight and obesity in the UAE children. Built environmental factors such as the walkability index, traffic exposure, and distance to school predict overweight and obesity in adolescents. As for parent perceptions, their willingness and perception predict the underweight category, while their education levels predict the overweight and obesity in the adolescents.

Discussion: The health category of adolescents is influenced by a range of factors, including the child's characteristics, built environment at meso and micro levels, and parents' willingness to let their children walk. Implications for the development of healthy communities and appropriate health policies are discussed in the context of the UAE.

KEYWORDS

adolescent health, parental perception, arid environment, United Arab Emirates, walking to school

1 Introduction

The arid landscape of the United Arab Emirates (UAE) has raised complex questions on allowing children to walk outside freely and is deeply rooted in the perceptions and concerns of parents. As parents navigate the unique cultural, environmental, and safety considerations of their surroundings, meso-level factors like the traffic, walkability, distance to schools, and physical activity levels can significantly impact children's mobility and independence (Badri, 2013). Additionally, micro-level determinants like the apprehension surrounding exposure to traffic, safety perceptions of both traffic and other users, as well as built environment contribute toward parental reluctance to permit children to walk unsupervised, underlining the necessity for policy interventions encouraging safe walking environments and promoting active commuting to schools (Maghelal et al., 2021; Kingsly et al., 2020).

A recent study reported that children in the UAE do not meet the recommended physical activity levels (Paulo et al., 2018), which has resulted in adverse impacts on their physical and mental health (Bunc and Skalská, 2016). Another study also reported that the health conditions in children in the UAE are deteriorating, with increasing obesity levels among children and adolescents (Al Junaibi et al., 2013). Earlier research on the prevalence of overweight and obese health conditions in the UAE (Alharballeh and Dodeen, 2023; Al-Haddad et al., 2005) reported that female obesity was 1.9-times that of the international standard while male children were overweight by almost 1.7 times and obese by almost 1.9 times compared to international standards by the age of 18 years. Thus, the frequency of obesity among adolescents in the UAE is approximately twice that of the recently published international standard. Investigations have revealed that the frequency of obesity in UAE is higher in youth aged 9–18 years compared to the international standards (Maghelal et al., 2021; Cole et al., 2000). Additionally, a recent review on adolescent health in the Gulf Cooperation Countries (GCC) reported that healthcare professionals in the region had limited or no training in adolescent healthcare (Al Makadma, 2017), while obesity among adolescents in the UAE had increased over the span of 11 years (2005–2016) and required immediate attention (Pengpid and Peltzer, 2020).

The overall objective of the present study is to investigate the impacts of parental perceptions of both micro- and meso-level variables on the health conditions of adolescents in Al-Ain, Abu Dhabi, UAE. Although the micro-level variables related to the built environment have been investigated extensively over the past two decades (Maghelal et al., 2011; Maghelal et al., 2021), meso-level variables like traffic exposure, walkability measures, distance to school, and willingness of the parents to let their children walk to school are not investigated sufficiently. These variables could be important mediating factors impacting the health conditions of the children. Therefore, the present study uses the socioecological model of physical activity to assess the health conditions of adolescents in the UAE.

Recent studies have used similar frameworks to assess health conditions in children and adolescents. For instance, researchers in Hong Kong examined the importance of physical activities for overweight and obese adolescents using body mass index (BMI) as a measure of the health condition and proposed interventions to reduce sedentary behaviors (Ma et al., 2014). However, another

study from Edinburg reported that the physical activity levels had little to no influence on the health conditions of adolescents (MacDonald, 2019). Therefore, there is a need to ascertain the physical activity levels that are positively related to health outcomes. Moreover, most of the reported studies investigate and provide targeted interventions only for overweight or obese children and adolescents (Ma et al., 2014; Ferrari et al., 2022), which could bias the interventions against underweight children. Most studies on health and physical activities have been presented in the context of the western world and are almost non-existent in the context of the middle east, which can provide important insights for arid environments like in the UAE.

Additionally, this study determines how parental perceptions and willingness for utilitarian activities, such as walking to school, are related to the health conditions of school-going children. Specifically, we ascertain how parental willingness and perceptions of the built environment are related the health conditions of children in the UAE ranging from underweight to obese. This is a critically important because the UAE must implement aggressive strategies addressing the safety concerns and environmental factors that currently deter parents from allowing their children to walk or cycle to school. Therefore, the outcomes of the study will be used recommend strategies to enhance the urban environment by prioritizing the development of safe walking paths and improving traffic management around schools (Bwire, 2020). These measures are intended to address the root causes of parental apprehension while creating a more pedestrian-friendly infrastructure; they can also empower families to embrace the positive impacts of active transportation, which would ultimately benefit the health, social, and emotional development of children. Moreover, the integration of non-infrastructure programs aimed at alleviating parental safety concerns, such as community awareness initiatives and safety workshops, could significantly bolster confidence in allowing children to travel independently, ultimately contributing to increased physical activity levels and improved public health outcomes in the region.

2 Walking to school: relevance to health conditions

The absence of a well-established culture of active travel in the communities of UAE has been identified as a significant factor influencing parental choices regarding the mode of transportation for their children (Badri, 2013). Furthermore, various demographic factors, including parental income and education, have been shown to significantly impact parental decisions allowing active travel. Notably, the parents of non-escorted children have expressed heightened concerns about the risk of their children's safety in general and specifically with regard to traffic (Mammen et al., 2012; Maghelal et al., 2021).

2.1 Socioecological model: driving physical activity and health

The socioecological model provides a comprehensive framework for understanding how the individual, societal, social,

and physical environment levels as well as public policies influence the physical activity levels of individuals (Sallis et al., 2015). This framework has been used previously to investigate both physical activity levels and health conditions (Woods et al., 2021; Simon et al., 2014). A recent meta-analysis of the determinants of adolescent physical activity using the socioecological model revealed that parents are prominent factors driving the physical activity levels and health outcomes (Zhao et al., 2025); this study recommended that both meso- and macro-level determinants, along with built environment variables, should be investigated for their roles in the activity levels and related health outcomes for advancing theoretical and policy frameworks for promoting physical activities. These interventions have been shown to effectively reduce obesity levels among adolescents (Feng et al., 2024; Simon et al., 2014) and hence need to be investigated rigorously in the context of the UAE.

2.2 Walking to school in an arid region

The arid environment of the UAE is characterized by high temperatures, limited rainfall, and sparse vegetation, which present unique challenges for adopting walking as the primary mode of transportation, particularly for school commutes. This climatic context not only affects the comfort and feasibility of walking but also amplifies parental concerns regarding the wellbeing of their children during the journey, necessitating the development of strategies incorporating environmental considerations to promote active travel (Nasrudin and Nor, 2013). In light of these challenges, it is imperative to design and implement shaded walkways, water stations, and other climate-responsive infrastructures that can mitigate the effects of heat and improve the overall walking experiences for children, thereby addressing parental anxieties and encouraging greater youth participation in active commuting. Leveraging community resources to create safe, accessible, and enjoyable walking routes as well as educational programs emphasizing the importance of physical activity in combating health issues can significantly influence parental decisions and perceptions, ultimately paving the path for a cultural shift toward active transportation in the arid environment of the UAE (AlBuhairan, 2015). Moreover, fostering partnerships between schools, local governments, and community organizations to raise awareness about the benefits of active travel as well as implementing safety measures, such as improved traffic control and surveillance along the walking routes, can help alleviate safety concerns while promoting a more favorable environment for children's independent mobility.

2.3 Walking and its impact on adolescent health

There is a global trend decline in active commuting to school, with a significant decrease observed in the United States, where the proportion of students aged 5–15 years who walked or biked to school decreased from 48% in 1969 to less than 16% in 2001 (Davison et al., 2008). This trend reflects the broader societal changes, including increased vehicle ownership and shift in cultural perceptions toward safety and convenience, which have collectively contributed to reducing the physical activity levels of children

and their independent mobility, thereby highlighting the urgent need for interventions that encourage active transportation among adolescents (Rattay et al., 2017; Pizarro et al., 2013). In particular, addressing the factors influencing parental choices, such as the absence of an active travel culture and underlying safety concerns, can play crucial roles in reversing this trend and fostering a supportive environment that encourages children to engage in healthier commuting practices, which ultimately benefit their health and wellbeing.

Promoting active commuting to school can have profound impacts on the health and wellbeing of children. Studies have shown that children who walk or bike to school tend to be more physically active overall, with higher levels of cardiovascular fitness and lower BMIs compared to their peers who are driven to school (Rattay et al., 2017), improved mental health outcomes like reduced anxiety and depression (Pizarro et al., 2013), greater physical development, and better reinforcement of essential life skills like responsibility and decision-making (Kirk et al., 2005).

As children navigate their surroundings independently, they become more adept at assessing risks and making informed decisions that not only boost their confidence but also equip them with critical thinking skills essential for the future (Davison et al., 2008). Considering these benefits, it is imperative for communities, especially those in urban environments, to create infrastructures that provide safe and appealing walking routes, thereby addressing both parental concerns and encouraging children to embrace active commuting as an integral part of their daily lives (Bwire, 2020).

2.4 Parental role in the independent mobility of children

The absence of an active travel culture in a community is a significant factor affecting parental decisions to let their children walk. This situation is compounded by the influence of parental perceptions, particularly regarding safety and the behaviors modeled by other families, indicating that many parents will continue to opt for motorized alternatives in the absence of a collective shift in attitude toward walking as a viable mode of transport, despite the potential benefits to their children's health and development (Ferrari et al., 2022). To facilitate a change in this mindset, it is crucial to engage parents through awareness campaigns that highlight not only the safety measures being implemented in schools but also the long-term advantages of allowing children to develop independence through active travel (Carlin et al., 2016). Parental concerns about safety stemming from high traffic volumes and perceived social threats often overshadow the benefits of physical activity and independence offered by walking, necessitating a comprehensive approach that combines educational initiatives with improvements in local infrastructure to foster a supportive environment for active commuting (Nasrudin and Nor, 2013).

The urban environment in the UAE is characterized by high traffic volumes, long distances between homes and schools, and limited pedestrian infrastructures, which have contributed to parental concerns on the safety of their children's commute. These safety concerns are compounded by the perceived social threats accompanying independent mobility as parents often navigate a complex landscape of cultural expectations and

socioenvironmental factors that influence their willingness to permit children to walk to school; this ultimately necessitates interventions targeted at addressing these multifaceted challenges. Furthermore, research indicates that parents express significant worries regarding traffic conditions and the potential dangers posed by unfamiliar individuals, underscoring the critical need for enhanced safety infrastructure and community awareness campaigns to foster a supportive environment for children's independent mobility (Ma et al., 2014).

Although the benefits of active commuting are well-established, many parents in the UAE remain hesitant to allow their children to walk or bike to school by citing concerns about safety as well as the perceived risks associated with the arid environment and high traffic volumes (Al Junaibi et al., 2013). This hesitation is compounded by the lack of an established active travel culture within the community, which can deter parents from feeling comfortable with their children's independent mobility and reinforce a reliance on motorized forms of transport, ultimately hindering opportunities for children to engage in physical activity and develop essential life skills. Adding to this complexity is the distance to school, which has been shown to be an important determinant of adolescent walking or biking to school, leading to parental deterrence to let their children walk or bike to school (Mandic et al., 2022). It is also noted that social influences, such as peer behaviors and community norms, as well as individual aspects like the parents' own commuting habits and willingness to prioritize sustainable transportation, play critical roles in shaping their attitudes toward allowing their children to engage in active modes of transport (O'Kane et al., 2020).

In summary, in the UAE context, the cultural and environmental factors contributing to parental reluctance to permit their children to walk or bike to school must be examined carefully to develop effective strategies addressing their specific concerns and to promote a shift toward more active and sustainable transportation choices. Therefore, examination of the parental perceptions and decision-making processes regarding the modes of travel of their children is crucial in the UAE context as it provides valuable insights into the complex interplay of cultural, environmental, and socioeconomic factors shaping such decisions.

3 Methodology

3.1 Study subjects

This study was conducted in the city of Al-Ain in the Emirate of Abu Dhabi, which is the capital and also the largest of the seven Emirates of the UAE. Parents of school-going children in the age range of 14–20 years (10th to 12th grades) from seven schools in Al-Ain were surveyed for this study. The Department of Education and Knowledge (ADEK) granted approval to the research team to survey the school students and their parents from these selected public and private schools, and the Institutional Review Board (IRB) of Khalifa University granted approval for this research involving human subjects.

3.1.1 Study school selection

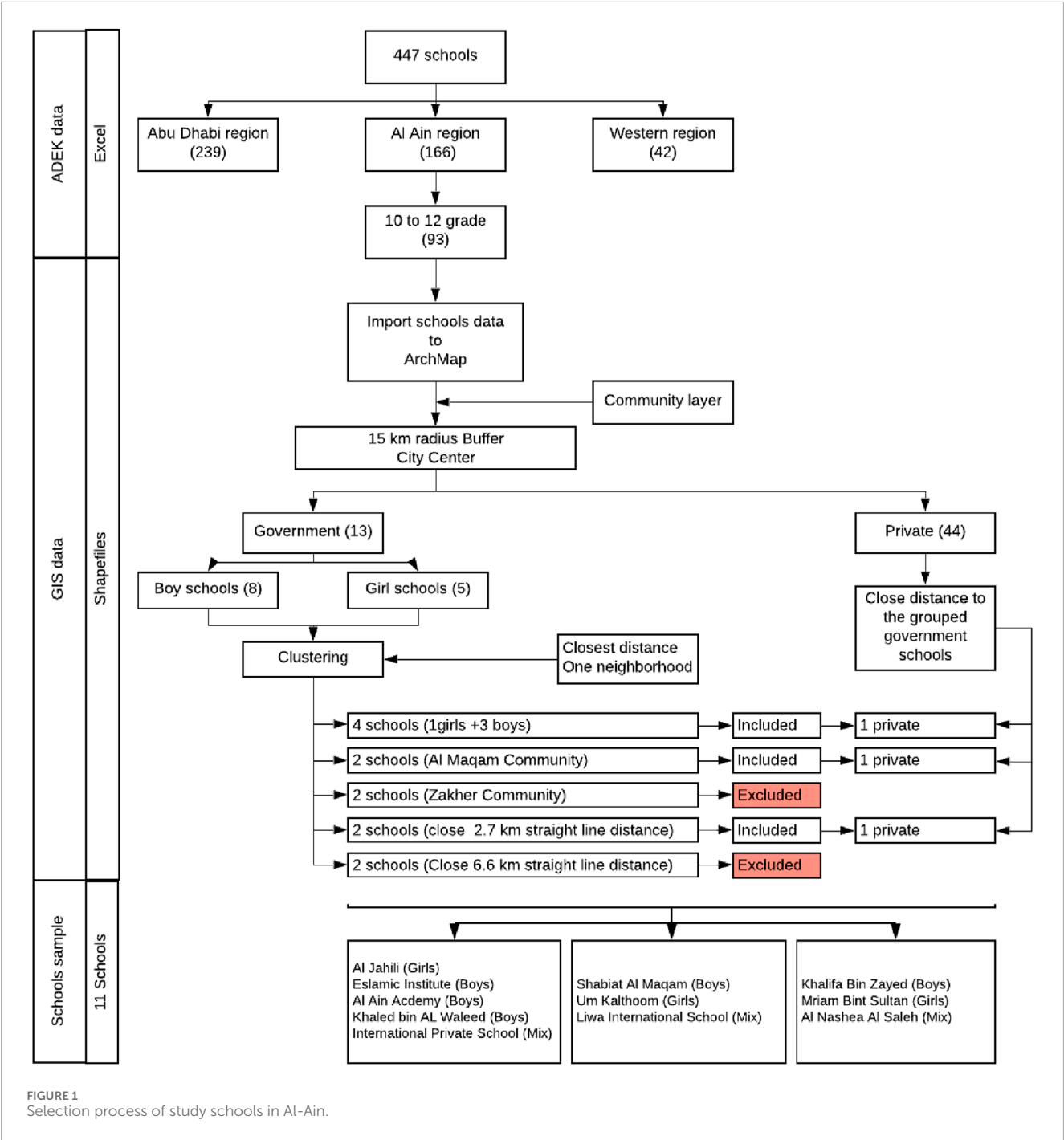
As all public schools in the UAE are segregated by gender, one school each enrolling boys and girls from the same district were

selected for this study. Private schools in the UAE have coeducation facilities for both boys and girls in the same school. Based on the data available from ADEK, a total of 166 schools were identified in Al-Ain, of which 93 schools had grades 10–12 that were the appropriate student groups for this study. Based on spatial clustering, recommendations from ADEK, and exclusion of schools in the same study zones, a total of 11 schools were identified as eligible for this study (Figure 1); this list was further narrowed to eight schools owing to either school closures or changes in the grade levels that were not suitable for the study. The study researchers then visited these schools for their interest in and approval to participate in the survey. Finally, seven schools were shortlisted to participate in the study (Figure 2).

3.1.2 Survey content and administration

The survey developed for the present study was adapted from the validated Home Environment Survey (HES) based on the socioecological model of physical activity (Pinard et al., 2012; Gattshall et al., 2008). Some questions in the survey were altered to reflect the sociodemographic conditions of the UAE and were translated into Arabic before being retranslated into English for ease of interpretation and understanding. Following a pilot study to pretest the survey, all students and parents were asked to complete the survey related to children's health, access to schools, perceptions of the built environment, willingness to let the children walk to school, improvements to the built environment factors that would encourage walking, and personal sociodemographic details. The survey also included informed consent and was available in both English and Arabic.

A recruitment letter was sent to all eligible students of the selected schools that informed them about the overall objectives of the study, consent regarding their participation or withdrawal, purpose of the study, working procedures, potential risks and discomfort, potential benefits, and confidentiality. Additionally, the recruitment letter included a form for parental permission allowing the children to be involved in the study. The parents who volunteered to participate in the study were provided surveys that could be completed in either English or Arabic. Parents from six of the seven schools provided consent to participate and/or allow their children to participate in the study. The parents of students attending one school deferred permission owing to cultural restrictions. The survey was administered to the parents by the head teachers at the schools who were trained regarding the study purpose and content of the survey. The volunteer parents were asked to complete the survey and return the same to the head teacher of the class through their children. A total of 207 consenting parents responded to the survey. However, only 163 of the 207 responses (78.7%) were valid and had sufficient material to be considered for this study; this was because some parents did not respond to the survey or had two or more children in the family who attended the schools, hence requiring only one survey response from the parents. The parent responses were mapped with the responses of their children to avoid duplication. It must be noted that although 163 responses were obtained in total, not all the parents responded to all of the survey questions, which resulted in a total of only 70 responses for the full model.



3.2 Measures

Dependent variable (health condition): The parents of the children who participated in this study were asked to assess and report on the actual heights and weights of the adolescents as part of the survey. Based on the age and gender, the BMI of each student respondent was categorized as “underweight,” “normal weight,” “overweight,” or “obese” for the health condition in accordance with the standards of the International Obesity Task Force [24]. Studies reported over the past two decades (Parry et al., 2010; Butler et al., 2019) have typically assessed the

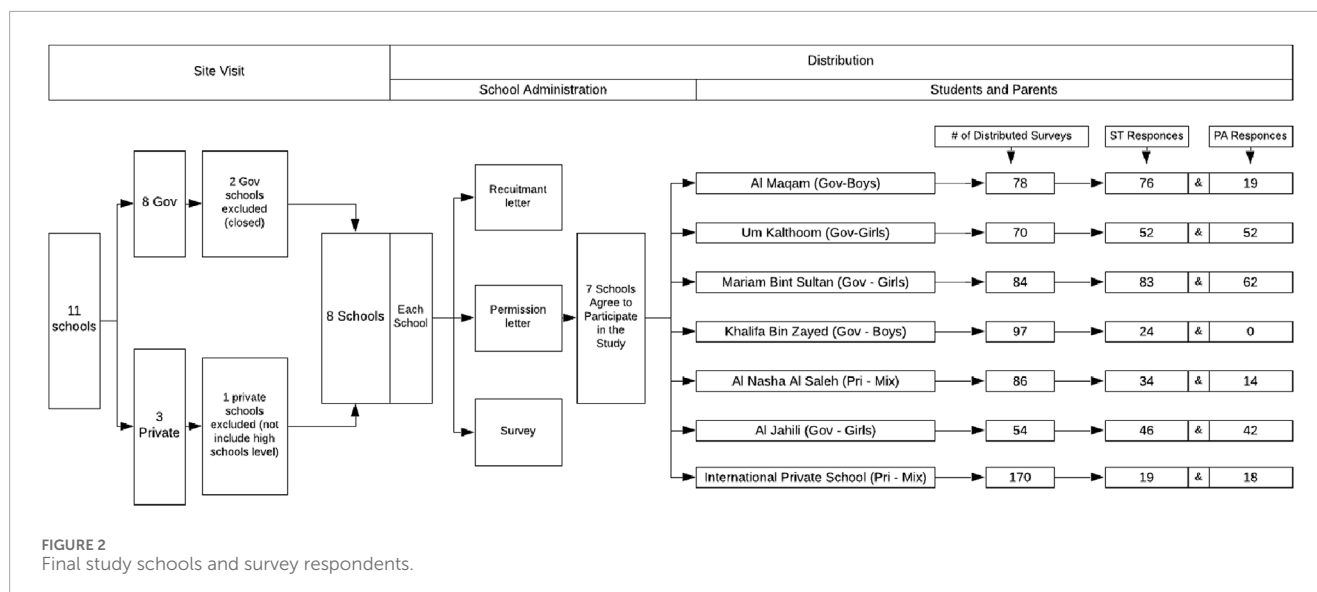
health condition using these categorizations to (1) understand the distribution of children’s health across various health levels, especially overweight and obese, and (2) provide implications specifically for categories like underweight, overweight, and obese in comparison to normal weight conditions. Hence, the BMI as the categorical measure of health condition was considered as the dependent variable and calculated by dividing the weight of each student in kilograms by the square of their height in meters.

Physical activity score: This score was calculated based on student responses regarding their active and sedentary behaviors

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in a typical week. The students were asked to provide information about the number of days in a week that they were active (non-exercise or sports), engaged in some sport in the day (in terms of number of times a day), and number of days in a week that they exercised. Moreover, they were asked to report the number of days when they did not engage in any of these activities and spent time watching TV or playing video games. The responses were then summed to develop the physical activity score. If the alpha value of the score exceeded 0.65, it was used for further analysis. It is noted that while the minimum–maximum scores ranged from –7 to 35, the minimum and maximum reported scores ranged from –5 to 27 and were thence divided into five activity categories. These categories were as follows: sedentary (1: –5 to 0); low activity (2: 1–6); moderate activity (3: 7–13); high activity (4: 14–20); vigorous (5: 21–27).

$$PA_Score = \frac{ACTIVEDAYS(0-7) + SPORT(0-7) * SPORT_TIME(0-3) + EXERCISE_TIME(0-7) - SEDENTARY(0-7)}{(0-7)}$$

The categorization of these scores helps provide better implications for enhanced the activity levels from one category to another (Hupin et al., 2015; Araujo et al., 2024) rather than general implications to enhance physical activities among adolescents.

Walkability index: Spatial data for the emirate of Abu Dhabi (including Al-Ain) were provided by the Abu Dhabi Systems and Information Center (ADSIC) as well as the Department of Municipal Affairs (DMA). The walkability index for schools and homes was calculated as the sum of intersection density, residential density, and land use mix (Frank et al., 2010). The walkability index measures were calculated in ArcGIS for each pair of origin and destination locations using the approach shown in Figure 3.

The z-score for each variable, namely residential density, street connectivity, and land use mix, was calculated and aggregated for a distance of 400 m from each of the seven

schools and the residences of individual students using the following formula:

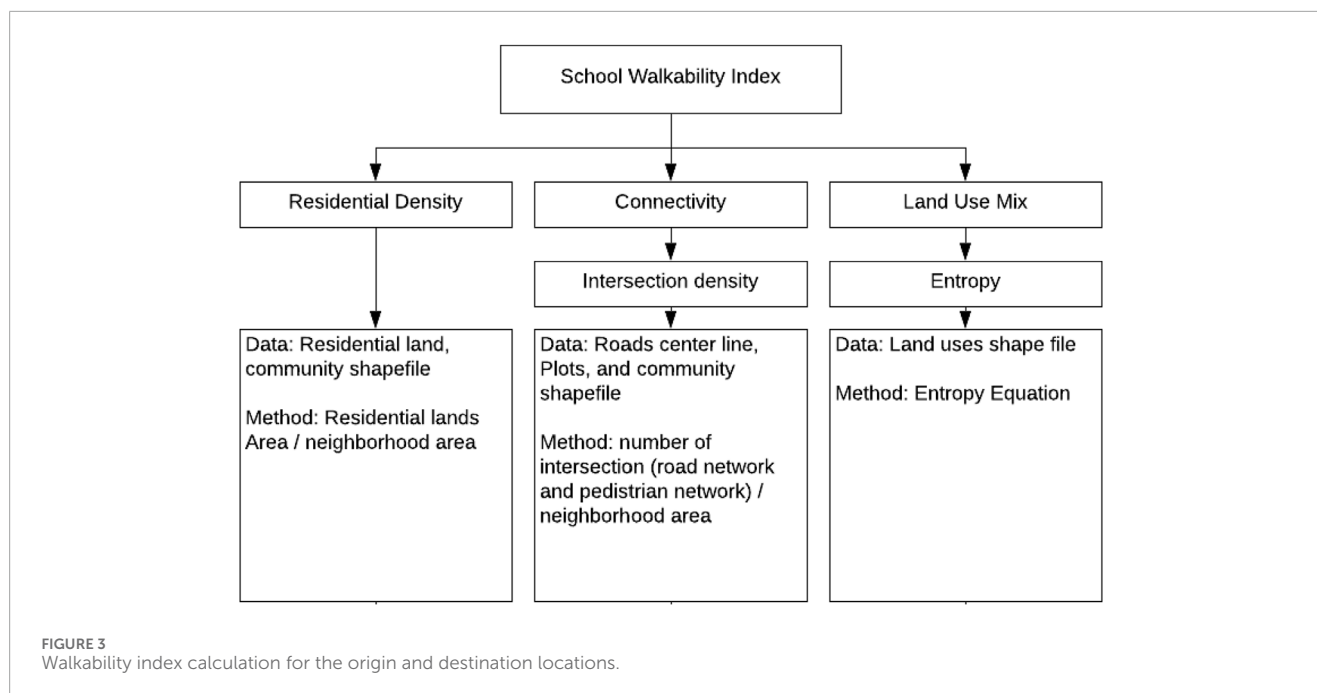
$$\text{Walkability index (WI)} = z - \text{score}(\text{residential density}) + 2 * z - \text{score}(\text{intersection density}) + z - \text{score}(\text{land use mix}).$$

Exposure to traffic: Since the ADEK regulations restrict students from crossing major roads with designated speeds of 40 kmph and above, we evaluated the traffic exposure as a measure of speed and calculated it as the ratio [length of (highways + major roads)/length of secondary roads] for the same catchment areas as those used for the walkability index at both the origin (home) and destination (school) locations (Militello et al., 2018).

Distance: The survey inquired about the distances (self-reported) of the students' homes from the schools, which ranged from less than half a kilometer (1) to more than 5 km (5). Those unaware of this information reported “don't know” in their responses, which accounted for almost 13% of the responses and were removed from further analyses.

Parental willingness: Parents were asked if they would let their children walk to school if their concerns regarding safety and infrastructure were addressed. These responses were coded as “1” for yes and “0” for no.

Parental perceptions: Parental perceptions were inquired as to the constructs of the sidewalks, streets, traffic, safety features, and appeal of the built environment. These included concerns such as sidewalks being too close to the traffic flow, widths of the roads, speeding of drivers, intensity of traffic, and unkempt sidewalks. Specifically, parents were asked as to which of the stated issues affected their decisions to allow their children to walk to/from school. The concerns were then grouped under six categories as sidewalks, street crossings, traffic and driver behaviors, safety, appeal, and others. Some specific concerns regarding sidewalks included the absence of sidewalks, blocked sidewalks, cracks in the sidewalks that made them unsafe for use, and sidewalks being situated too close to moving traffic. Each concern was coded



as “1” when selected or “0” otherwise, and the parents could choose all options within each construct. The concerns for each of the microenvironmental constructs were summed to calculate the corresponding parental perceptions.

Other variables: The gender of each child was coded as 1 for male or 2 for female; next, expats were coded as “0” and Emirati children were coded as “1.” The income levels of the parents were categorized into five groups ranging from 1 (less than 5,000 AED) to 5 (over 40,000 AED), while the education levels of the parents were designated as 1 for less than high school, 2 for bachelor’s degree, 3 for high school, 4 for master’s degree, 5 for precollege diploma, and 6 for doctoral degree.

3.3 Analysis

The health conditions measured under the four categories based on the BMI were analyzed using multinomial logistic regression. Here, normal condition was selected as the base outcome, while underweight, overweight, and obese were the other outcomes. The predictor measures were categorized based on student characteristics like age, gender, amount of physical activity (PA score), and nationality (local/Emirati or expat student).

The meso-level measures included the walkability index score and exposure to traffic at both origin (home) and destination (school) locations, with the distance from home to school being reported under the five specified categories.

The perceptions of the built environment regarding safety against traffic and physical safety, sidewalks, crosswalks, and appeal were grouped under the micro-level variables, while parental willingness to allow their children to walk and the sociodemographic characteristics were grouped under the parental characteristics for further analyses. Stepwise regression was then

performed to assess the roles of each of the three categories on the health outcomes of the students.

The stepwise multinomial regression analysis (*mlogit*) was conducted in STATA for the basic model (model 1: student characteristics), intermediate model (model 2: student + meso perception variables), and full model (model 3: student + meso + micro perception variables) to predict the various health conditions among adolescents in the UAE.

4 Results

The student distribution based on health category shows that the majority of the adolescents have normal weight (Table 1). The male (27%) and Emirati (18%) students were mostly obese compared to the other groups, whereas female adolescents were mostly found to be overweight (18%) compared to male adolescents (9%). It should be noted that the underweight category is often less investigated and is of concern as approximately 13% male adolescents and 12% Emiratis are reportedly underweight. Other studies have reported similar statistics in the UAE, with 8% of adolescents being underweight in the UAE (Abouchacra et al., 2021). Investigation into the various determinants related to lower weights in adolescents can provide important insights for students not only in the UAE but also globally as this is an understudied topic in most countries (Uzogara, 2016).

Most of the female respondents in this study were Emirati students having a mean age of approximately 16 years and belonging to the normal or overweight categories on average (Table 2). The residential locations of these respondents show low walkability index and higher traffic exposure values compared to their school locations, indicating the need for improved conditions in the areas where these children resided. On average, the majority of the students had residences within 1 km from their schools, and most

TABLE 1 Gender and nationality distributions across various health conditions.

Health condition	Gender		Nationality	
	Female	Male	Expat	Emirati
Underweight	6.37%	13.19%	6.67%	11.68%
Normal weight	61.15%	50.55%	60.00%	54.74%
Overweight	17.83%	8.79%	16.67%	15.33%
Obese	14.65%	27.47%	16.67%	18.25%

of the parents were concerned about the appeal, safety, and dangers of street crossing to let their children walk to school. Nonetheless, approximately 66% of the parents were willing to let their children walk to school if the concerns regarding the built environment were sufficiently addressed. Most of the parents earned monthly incomes of approximately 20,000–40,000 AED (5,400–10,800 USD) and had at least bachelor’s degrees.

4.1 Impacts of the micro and meso environmental variables on health conditions

The multinomial logistic regression results shown in Table 3 indicate the relationships among various independent variables (e.g., age, gender, PA score, meso-level and micro-level environmental variables, and parent characteristics) as well as the likelihood of being classified into different health categories (underweight, overweight, or obese) compared to the reference “normal weight” category. The multinomial logistic regression coefficients represent the logarithmic odds of having a specific health condition (underweight, overweight, or obese) compared to the normal weight category; here, a positive coefficient indicates an increased likelihood of being in the specific weight category with increase in the value of the independent variable, whereas a negative coefficient indicates a decreased likelihood of being in the specific weight category.

The pseudo R^2 value for model 1 (children’s characteristics) is 0.058 ($N = 163$), model 2 (children’s characteristics and meso-level variables) is 0.134 ($N = 128$), and model 3 (complete model) is 0.338 ($N = 70$). Furthermore, the model fit was better for the complete model (model 3), with the Akaike and Bayesian information criteria being lowest at 218.44 and 339.86, respectively, compared to the other two models.

4.1.1 Health condition: odds of being underweight

The odds of an adolescent’s health condition being underweight compared to the normal weight category was statistically significant

TABLE 2 Descriptive analysis of the determinants of health condition.

Variable	Mean	Standard deviation	Min	Max
Children’s characteristic				
Health code	2.44	0.90	1	4
Age	15.74	1.21	14	20
Gender	1.36	0.48	1	2
PA score	2.16	0.82	1	5
Local/expat	0.70	0.46	0	1
Meso-level variable				
Walkability index (origin)	−0.76	4.83	−68.67	4.51
Traffic exposure (origin)	0.27	0.27	0.07	2.34
Walkability index (destination)	0.39	1.20	−1.94	2.27
Traffic exposure (destination)	0.21	0.14	0.07	0.51
Distance to school	1.54	0.82	1	5
Micro-level variable				
Perception of sidewalk	1.27	1.40	0	5
Perception of street crossing	2.19	2.11	0	9
Perception of traffic	1.87	1.97	0	7
Perception of safety	2.11	1.85	0	8
Perception of appeal	2.41	1.90	0	8
Parental characteristic				
Willingness to let their child walk	0.66	0.48	0	1
Income	4.27	1.70	1	5
Education	2.84	1.31	1	6

TABLE 3 Multinomial regression of adolescent health conditions.

Determinants of health condition	Underweight			Overweight			Obese		
Children’s characteristic									
Age	0.05 (0.22)	0.05 (0.24)	0.07 (0.62)	−0.19 (0.21)	−0.43 (0.28)	−0.95 (0.45)**	0.12 (0.20)	−0.09 (0.21)	−0.87 (0.47)*
Gender	1.16 (0.56)**	1.40 (0.67)**	5.89 (2.55)**	−0.84 (0.61)	−0.70 (0.91)	1.12 (1.40)	1.20 (0.48)**	1.59 (0.59)***	2.48 (1.49)
PA score	−0.61 (0.33)*	−0.74 (0.39)*	−1.78 (0.98)*	−0.21 (0.37)	−0.58 (0.37)	−0.34 (0.54)	−0.65 (0.29)**	−0.58 (0.33)*	−0.34 (0.70)
Local/expat	0.62 (0.61)	0.38 (0.73)	22.58 (6.34)***	0.35 (0.50)	0.15 (0.68)	1.26 (1.26)	0.01 (0.50)	0.43 (0.75)	1.94 (1.29)
Meso-level variable									
Walkability index (origin)		0.01 (0.03)	−2.54 (1.40)*		0.05 (0.16)	−0.49 (0.41)		0.03 (0.03)	−0.8 (0.33)**
Traffic exposure (origin)		−1.28 (1.62)	2.43 (3.84)		2.23 (1.28)*	4.30 (2.16)**		2.18 (1.27)*	3.82 (1.88)**
Walkability index (destination)		−0.21 (0.37)	−0.51 (1.13)		0.42 (0.39)	−0.24 (0.72)		−0.25 (0.30)	−0.63 (0.67)
Traffic exposure (destination)		1.05 (2.78)	−9.67 (8.71)		−5.86 (3.03)*	3.00 (4.18)		0.12 (3.45)	7.75 (5.39)
Distance to school		−0.49 (0.55)	2.61 (2.67)		−0.07 (0.53)	−3.93 (1.79)**		−0.48 (0.42)	−2.62 (0.92)***
Micro-level variable									
Perception of sidewalk			1.53 (0.79)*			0.27 (0.41)			0.46 (0.34)
Perception of street crossing			0.87 (0.40)**			0.07 (0.21)			−0.38 (0.30)
Perception of traffic			−2.3 (1.03)**			−0.13 (0.44)			−0.11 (0.33)
Perception of safety			0.28 (0.54)			−0.18 (0.31)			−0.47 (0.34)
Perception of appeal			−0.56 (0.40)			−0.50 (0.54)			0.32 (0.39)
Parental characteristic									
Willingness to let their child walk			−3.11 (1.55)**			−0.25 (1.12)			0.66 (1.46)
Income			0.47 (0.52)			0.05 (0.30)			−0.25 (0.29)
Education			0.68 (0.64)			−1.26 (0.42)***			−1.35 (0.52)***

(Continued on the following page)

TABLE 3 (Continued) Multinomial regression of adolescent health conditions.

Determinants of health condition	Underweight	Overweight	Obese
N	163	128	70
$P > \chi^2$	0.014	0.014	0.000
Df	15	30	54
Pseudo R^2	0.058	0.134	0.338
Akaike information criterion	392.5167	325.5657	218.4439
Bayesian information criterion	438.9229	411.1266	339.8627

Boldface values indicate significant results. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

with respect to gender, PA score, nationality, walkability score around their residence, and willingness of their parents to allow walking, as well as parental perceptions of the sidewalk, street crossing, and existing traffic on the streets.

The gender coefficient was consistently positive while the PA score was consistently negative, indicating that male students were more likely to be underweight compared to the reference group while higher PA scores were associated with lower likelihoods of being underweight. Contrary to expectations and the outcomes of other studies, Emirati students were more likely to be underweight than expat students.

Higher walkability levels are negatively associated with students being underweight compared to the reference group, indicating that better walking environments were associated with lower odds of the children being underweight; similarly, higher willingness levels of parents to let their children walk were associated with lower odds of the adolescents being underweight. Conversely, higher parental concerns with the microenvironment like sidewalks and street crossings were associated with higher odds of the children being underweight, indicating the need for better and safe built environments to improve the parental perceptions. The odds of the children being underweight were negatively related to parental concerns regarding road traffic; this result does not conform to the findings reported in current literature and requires further investigation.

4.1.2 Health condition: odds of being overweight

Increases in age, exposure to traffic, and distance from home to school as well as higher education of parents were significantly related with the adolescents being overweight compared to the reference group. Higher exposure to traffic at the origin (home) was positively associated with the odds of adolescents being overweight, while longer distances from the homes to schools were negatively correlated, indicating that longer distances were associated with lower odds of the adolescents being overweight. Similarly, the odds of being overweight reduced with increasing education levels of the parents, indicating that parents with higher levels of education could be making conscious efforts to reduce the likelihood of their child being overweight.

4.1.3 Health condition: odds of being obese

The positive association between the male gender and traffic exposure near the home indicates that such students are more likely to be obese. On the contrary, increased age of the adolescent, higher walkability scores at the origin location, increased distance from home to school, and parental education level had negative associations; this means that older adolescents have a lower likelihood of being obese compared to the reference group. Similarly, increased walkability near the home and increased distance from home to school reduce the odds of the adolescent being obese.

Parental education was observed to have a negative coefficient, indicating that higher education levels of parents were associated with lower odds of the adolescents being obese; this could again be associated with the parents' awareness of their children's health and proactive encouragement of kids to be active, which would reduce the likelihood of them being obese.

The results show that multiple factors, including demographic, environmental, and behavioral factors, can significantly influence children's weight status to varying degrees of impact depending on their weight category. Thus, the gender and physical activity scores predict the obese and underweight categories of adolescent health condition, while age predicts overweight and obese conditions in children in the UAE. The meso-level variables like walkability index and traffic exposure with distance predict overweight and obese conditions in adolescents, whereas micro-level variables like parental willingness and perceptions predict the underweight category and parental education levels predict overweight and obese conditions in adolescents.

5 Discussion and implications

5.1 Addressing parental concerns on adolescent health outcomes

In the context of the UAE, the health categories of adolescents are influenced by various factors, including the children's characteristics, meso- and micro-level variable of the built environment, and parental willingness to let the children walk. This complexity illustrates the need for tailored interventions that consider these demographic factors

while also addressing the overarching cultural norms surrounding child mobility; for instance, [Badri \(2013\)](#) reported that lack of an established active travel culture in a region could underscore the importance of developing initiatives that specifically target these elements for driving changes.

One promising strategy to address parental concerns and encourage active commuting is the implementation of comprehensive school-based programs that promote walking and biking, such as the “Walking School Bus” or “Bike Train” initiatives ([Kwon et al., 2022](#); [O’Kane et al., 2020](#)). These programs involve organized groups of children walking or biking to school together under adult supervision, which can significantly enhance the perceived safety of these commuting modes and alleviate parental concerns. By fostering a sense of community and encouraging structured and supervised travel, such initiatives not only increase children’s physical activity levels but also contribute to a cultural shift toward embracing active commuting as a safe and viable option for school travel, thereby addressing the current reliance on private vehicles ([Almardood and Maghelal, 2020](#)).

Additionally, the development of safe and appealing walking and cycling infrastructures, such as well-maintained sidewalks, bike lanes, and crosswalks, can greatly enhance the perceived safety of active commuting and address parental concerns about the hazards posed by the arid environment and heavy traffic in the UAE. Recent studies from the UAE ([Pimenta et al., 2021](#); [Zami et al., 2025](#)) have identified safety- and comfort-oriented environmental factors, such as barrier-free walkways, need for greenery, and safety from traffic, as some of the key recommendations to enhance walkability in the region. Other specific policy and design implications that evolve from the outcomes of the present study are discussed below.

5.2 Implications for health and public policies

Since male students were found to be more likely to be underweight or obese, policies should address these specific risks through gender-sensitive health promotion programs focusing on balanced nutrition and healthy weight gain. A recent study from the UAE reported that male adolescents tended to be more sedentary than female adolescents and that female adolescents tended to be more cautious of road safety in their decision to walk ([Maghelal et al., 2021](#)). Moreover, higher physical activity scores and better walkability were associated with decreased likelihoods of being underweight or obese. Thus, public policies could promote physical activity through safe and accessible walking paths, parks, and recreational areas. In context of the students being expats or Emiratis, the finding that Emiratis are more likely to be underweight than expats suggests that cultural or socioeconomic factors may influence health outcomes. Hence, policies may need to consider culturally sensitive health interventions that address specific dietary practices or lifestyle factors prevalent in local communities. For instance, [Baobeid et al. \(2021\)](#) reviewed popular walkability indices and frameworks and reported that the interventions should be more inclusive and sensitive to the sociocultural characteristics of communities. In terms of the parental influences on the health outcomes of students, the negative association between parental education levels and the odds of their children being overweight

or obese suggests that increasing parental awareness and education about adolescent health could be an effective strategy ([Al-Ali et al., 2020](#)). Policies could therefore focus on providing educational resources to parents about nutrition, physical activity, and the importance of a healthy lifestyle.

The built environment both at the micro- and meso-levels is critical for allowing children to walk to school. For instance, traffic exposure near homes is linked to higher odds of obesity, while parental concerns about sidewalks and street crossings are associated with higher odds of being underweight ([Zhu et al., 2008](#)). Hence, policies should focus on improving traffic safety and reducing exposure to traffic hazards to mitigate these risks ([Esteban-Cornejo et al., 2016](#)). Additionally, the negative association between distance from home to school and likelihood of being overweight or obese suggests that encouraging walking or cycling to school could be beneficial. Policies could thus promote programs on safe routes to school and support infrastructures that encourage active commuting.

5.3 Implications for healthy communities

Health education campaigns and physical activity programs could be tailored to appeal more to male adolescents, addressing their specific nutritional and physical activity needs. Urban design practices should prioritize walkable neighborhoods with safe sidewalks, crosswalks, and traffic calming measures to create safe low-traffic zones around schools and residences that are well-maintained and perceived as safe by parents ([Maghelal et al., 2021](#)). This would not only encourage physical activity but also alleviate parental concerns about safety, further encouraging children to walk.

A recent study by [Lam et al. \(2023\)](#) reported that encouraging physical activity among school children would require collaborative efforts among schools, parents, and the government and should be tailored to address multilevel determinants within the local context. Therefore, health- and community-based programs involving parents in health promotion activities could be designed to empower them with the knowledge and tools needed to support children’s health. Schools could also play important roles by incorporating health education into parent-teacher meetings or through workshops. Health programs and educational materials should be designed to be culturally relevant and accessible to different demographic groups, ensuring that the interventions resonate with local values and practices. In line with this recommendation, the World Health Organization has proposed eight global standards to improve the quality of healthcare services for adolescents, such as adolescent health literacy, community support, equity, and non-discrimination of adolescent participation ([World Health Organization, 2014](#)). These standards can be used as essential guides for developing better adolescent health plans locally and globally ([Nair et al., 2015](#)).

In summary, our findings suggest the need for holistic policies and urban design strategies that consider multifaceted influences on adolescent health, from gender and cultural background to environmental factors like walkability and traffic exposure. Collaborations among policymakers, urban planners, educators, and public health officials will also be crucial in implementing effective interventions ([Alawadi et al., 2022](#)).

6 Conclusion

The roles of parental perceptions of the micro-level environment and willingness to let their children walk to school are related to health categories like being underweight, overweight, or obese. Furthermore, at the meso-level, the physical environment of the schools and residences can influence the health of children. The present study provides insights into which of these determinants have positive and negative relationships with the health levels of adolescents in the UAE. Although the findings of this study are imminently relevant to the UAE, the implications are valid for most Middle Eastern nations as all these countries share similar sociodemographic, cultural, and topological characteristics, especially the arid environment in the region.

The parental perceptions of the arid environment of the UAE is a complex and multifaceted issue, where a range of factors influence the decisions to allow or restrict independent mobility of their children. Understanding these dynamics is essential for developing effective policy interventions that not only address safety concerns but also promote a culture of active transportation, ultimately contributing to the wellbeing of children and the community as a whole (Badri, 2013). Moreover, fostering collaborations among schools, local authorities, and community organizations will be essential in implementing these initiatives by ensuring that a holistic approach is adopted to create a safer and more encouraging atmosphere for children to walk to school independently, which in turn can substantially enhance their physical, social, and emotional development. These collaborative efforts should also prioritize the inclusion of parental inputs in decision-making processes as their experiences and insights can provide valuable guidance in creating practical and effective solutions that resonate with the unique context and needs of the community (Jelleyman et al., 2019). Furthermore, the establishment of programs that highlight the positive impacts of walking on children's health while promoting shared learning experiences among families can help shift perceptions and reduce the reliance on private vehicles for school commutes, ultimately fostering an environment where active transportation becomes the norm rather than the exception (Kwon et al., 2022). In this context, engaging parents through targeted educational campaigns that address their concerns while simultaneously showcasing the myriad benefits of active transportation for children—such as improved physical health, enhanced social skills, and greater self-reliance—will be vital for driving change and encouraging a more pedestrian-friendly culture in the urban centers of the UAE (Yammine, 2017). In this regard, collaborative efforts involving parents, schools, and local governments can pave the path for creating a safer and more supportive environment, thereby fostering a shift toward active commuting that promotes the health and development of children while enhancing community connections and sustainability (Fonseca et al., 2022).

Although the outcomes of this study provide important implications for health policy and planning, they are limited in terms of applicability to non-arid and western/eastern countries. Similar studies that assess the health levels of children can be conducted in other nations to compare the results and develop holistic policies for improving adolescent health. Moreover, some results, such as the relationship between road traffic and being underweight, do not

align with the findings in existing literature, indicating the need for further investigations. Policies should support ongoing research to better understand these anomalies and refine interventions accordingly. Finally, research findings should be integrated into the iterative design process, where urban planners and public health professionals collaborate to refine strategies that address emerging health trends and challenges.

In conclusion, the roles of the built environment at both the micro- and meso-levels are critical factors in determining the travel modes of school children in the UAE, particularly given the arid environment. Understanding the interplay between environmental conditions and parental perceptions is essential for developing effective interventions that encourage active transport, as it highlights the need for a multifaceted approach addressing both physical infrastructures and community attitudes toward the independent mobility of children in a context where walking is often perceived as a challenge, resulting in unhealthy outcomes for adolescents.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the author, without undue reservation.

Ethics statement

The studies involving humans were approved by the Institutional Review Board (IRB) of Khalifa University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

PM: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review and editing.

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The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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