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Influence of the Built Environment on Physical Activity Choices among Emirati Male and Female Adolescents: An Examination of Parents' and Students' Perceptions

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Abstract: The UN Human Development Report 2020 ranked the United Arab Emirates (UAE) as having achieved 'very high human development' and as being at the 31st position among all countries. Despite this, the ever increasing obesity rates among Emirati youth, higher than international standards, is alarming. This research aims at identifying how different perceptions of the built environment by parents and adolescents are likely to affect physical activity (PA) choices among male and female Emirati youth. This can help inform better health and education policies to achieve three of the interconnected UN Sustainable Development Goals (SDGs), namely good quality health and well-being, quality education, and gender equality, that the UAE strives to achieve. Responses from 335 students (aged 14–20) from six schools and 250 parent responses in the Al Ain region of Abu Dhabi Emirate were used to understand the mean variation in perception of five built environment constructs. Further, multinomial logit regression was used to assess the health condition using the perception, behavior, and built environment measures. Results indicate that Emirati males perceive the built environment factors as barriers more than female adolescents. Parents perceive street crossing ($p < 0.016$) and sidewalk characteristics ($p < 0.020$) to be more of a hindrance. Traffic exposure, self-reported physical activity, and walkability near homes and schools significantly affect Emirati adolescents' health conditions. Recommendations are made for various stakeholders including parents, school authorities, Abu Dhabi Municipality and Transportation, and the Urban Planning department on ways to enhance the built environment and encourage PA and well-being of Emirati adolescents.

Keywords: obesity; health condition; Emirati adolescents; parent perception; United Arab Emirates

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1. Introduction

The UN Human Development Report 2020 [1] ranked the United Arab Emirates (UAE) as having achieved 'very high human development' and as being at the 31st position among all countries. Despite this, in recent years, health statistics reports from the UAE have found that obesity among children and adolescents in very high and on the rise [2]. Some scholars believe that it is two to three times higher than international standards [3,4] and is directly correlated to the low levels of physical activity (PA) [5]. As per the US Centers for Disease Control and Prevention (CDC) [6]:

> Children and adolescents ages 6 through 17 years should do 60 min (1 h) or more of moderate-to-vigorous intensity physical activity each day, including daily aerobic—and activities that strengthen bones (such as running or jumping)—3

days each week, and that build muscles (such as climbing or doing push-ups)—3 days each week.

However, a 2016 study confirmed that the current lifestyle choices inhibits Emirati children from reaching these internationally prescribed levels of PA per day [7] and thereby increases the adverse impacts on their health, including obesity rates among children and youth [8].

The UAE features an arid desert climate with hot summer temperatures in April to October ranging from 38 °C to 42 °C (101 °F to 108 °F) and cool winters. These high daytime temperatures for over half the year, interspersed with strong winds and dust storms, often make walking outdoors uncomfortable. This is compounded by a lack of walking or bike-friendly pathways around most schools and residential areas, likely leading to a negative perception of the built environment and thereby lesser engagement in walking activities [9].

The perceptions of parents and children on the safety of the built environment or the hindrances and challenges these pose to engaging in physical activities have shown mixed results. Some studies suggest the parents often exhibit concerns related to the different factors (demographic and built environment factors) that usually deter the use of nonmotorized transportation modes [10]. Other studies report that parents are more likely to exhibit high levels of confidence regarding their children's capability to navigate the built environment safely [11]. In addition, seemingly independent children are often capable of taking care of themselves and can maneuver traffic and the networking routes to reach the intended destination, whether it is school or home [12]. This attitude thus plays a critical role in the parent permitting the child to walk to school or to utilize the inactive means of transportation that is often more secure [13]. Furthermore, gender studies report male children to be more physically active than females [14], and hence, several studies focus on improving the health and activities for female children and adolescents [15].

Parental and child safety concerns are likely to be reduced by the creation of safer routes to schools by reducing traffic volume and speed as well as improving the availability and quality of sidewalks in neighborhoods surrounding schools. The integration of strategies that make safer school routes and ease concerns surrounding safety by educating children about walking safely in their neighborhoods has been recommended to encourage safe and effective walking [16].

To enhance the safety of school neighborhood, the executive regulation concerning the school transport by the Abu Dhabi Department of Education and Knowledge (ADEK) restricts students from crossing major roads with a designated speed of more than 40 kmph to reduce exposure to high traffic. The built environments around the schools and homes of the school-going children do not support walking in general. This could hinder a student's or parent's choice of walking to school and hence reduce opportunities for physical activity. This may lead to a negative perception of the built environment for both the parents and the children, as individuals who usually are not engaged in walking have a higher negative perception of the environment [9].

Conversely, built environment factors such as distance, travel time, safety, urban form and density, land use, street design (i.e., speed limit, traffic capacity, sidewalk, crosswalk, street connectivity), and route network relate to active modes of transportation to school [17–19]. Neighborhoods with a high score of walkability, i.e., high street connectivity and low traffic, have witnessed an increased likelihood of children walking to school and higher levels of PA. Conversely, neighborhoods that have high connectivity in addition to high traffic volumes have children who are less likely to walk. This deters them from achieving the recommended levels of PA and negatively impacts their satisfaction levels and the social capital of the neighborhood [20]. Thus, the built environment factors such as the land use mix, residential density, and street connectivity around homes and schools need to be assessed to accommodate a higher concentration of pedestrians and provide design and policy recommendations [21,22].

Most adolescent studies analyze the impact of health determinants on overweight or obesity [21] and not on overall health, including being underweight, even when undernutrition remains a cause of death in children worldwide [22]. Few studies in the last decade

have investigated the determinants of obesity in the UAE or the Emirati population and even less specifically target the adolescent population [3]. Most studies focus on either obesity or overweight and not on the overall health condition among the UAE population [2]. To our knowledge, none of them included parent perception to analyze the overall health of the Emirati adolescents as comprehensively. Additionally, we examine the predicted probabilities of levels of physical activity on health conditions of Emirati adolescent, a rarity in obesity studies.

In summary, the study analyzes the role of both subjective and objective determinants of the built environment on parents' and adolescents' perceptions, the effect of constraints such as traffic exposure on the levels of physical activity, and finally the effect on health conditions of Emirati adolescents. Specifically, we examine: What is the health condition (underweight to obese) of Emirati adolescent in the UAE? How do perceptions of built environment vary across male and female Emirati adolescents? Do perceptions of built environment of parents differ from those of their children? What objective and perceptive measures of built environment of the adolescents and the parents have significant relation with the health conditions of Emirati Adolescents of the UAE?

The findings of this study have important implications in trying to propel the country into achieving the 17 UN Sustainable Development Goals through the UAE National Agenda Vision 2021 [23], three of which are primarily intertwined with the outcomes of this study, namely 3. Good Health and Well Being, 4. Quality Education, and 5. Gender Equality. It can also help to better inform school officials, parents, students, and people designing the built environment on ways to enhance it to facilitate more opportunities for the youth to be physically active. It should be noted that all adolescents referred to in this study are 'Emirati' adolescents.

2. Methods

2.1. Study Area

This study was conducted in the emirate of Abu Dhabi, the capital of UAE and also the largest of the seven emirates, as it occupies 87% of the total area of the UAE. The emirates of Abu Dhabi consists of three regions: Abu Dhabi—the capital central region, the Al Ain region, and the Western region, as shown in Figure 1.

Figure 1. The city of Al Ain is located in the eastern side of the Capital Center and shares its borders with the Sultanate of Oman.

2.2. Study Population

School-going children aged 14 to 20 years (10th to 12th graders) from six schools in Al Ain were selected for this study. The Department of Education and Knowledge (ADEK) granted approval to the research team to survey school students and their parents from these select public and private schools, while the Institutional Review Board (IRB) granted approval for this human subjects research. Informed consent was obtained from the parents and adolescents for the study. As all public schools in the UAE are segregated by gender, a pair of boy's and girl's schools from the same district were selected. One private school from one of these districts was also included in the study.

2.3. Survey Content and Administration

All parents were sent informed consent forms describing the study and its expected outcomes and a request for their voluntary participation and permission to let their child participate, as well. The sample of student respondents completed the survey in school, while parents who volunteered filled in their responses on a hard copy of the survey and sent it back to school with their child. The schoolteachers and officials were informed of the purpose and goals of this study in detail, and all their queries were answered beforehand; they helped collect the responses. Respondents were asked about their socioeconomic and demographic background, questions related to physical activity, and perceptions of built environment as facilitators of inhibitors to healthy behaviors. Both the student and parent surveys were translated into Arabic (the local language in UAE) and then administered to the respondents, and then, once collected, back translated to English by the research team.

2.4. Measures

2.4.1. Dependent Variable: Health Condition

The measure of the Body Mass Index (BMI) based on a student's age and gender was categorized as 'underweight', 'healthy weight', 'overweight', and 'obese' health condition for each student respondent, following the International Obesity Task Force (IOTF) [24] standards. This categorical measure of health condition, the BMI, was the dependent variable and calculated by dividing the weight of each student by the square of his/her height.

2.4.2. Physical Activity Score

The physical activity score was calculated based on student's responses about their active and sedentary behaviors. Students were asked to provide information about the length and frequency of the sport, exercise, watching TV, and playing video games in a day. The responses were then summed to develop the physical activity score. The alpha value of the score was over 0.65 and hence was used further for the analysis. The outcome categories ranged as follows: sedentary (1: −5–0); low activity (2: 1–6); moderate activity (3: 7–13); high activity (4: 14–20); vigorous (5: 21–27).

2.4.3. Built Environment Perceptions

Perceptions of parents and adolescents were gathered relating to various constructs of built environment such as the sidewalk, streets, traffic, safety, and appeal of the built environment. Specifically, these include concerns such as the sidewalk being too close to traffic, wide roads, speeding drivers, intensity of traffic, and unkempt sidewalks. The concerns for each of the above constructs were summed up to calculate the perception of concerns related to the five built environment constructs.

2.4.4. Walkability Index

The walkability index for schools and homes was calculated as the sum of intersection density, residential density, and land use mix [25]. The z-score for each variable—residential density, street connectivity, and land use mix—were calculated and aggregated for 400 m

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

$$\text{Walkability Index (WI)} = \text{z-score (residential density)} + 2 \times \text{z-score (intersection density)} + \text{z-score (Land use mix)} \quad (1)$$

2.4.5. Exposure to Traffic

Since the regulation by the ADEK restricts students from crossing major roads with designated speeds of 40 km/h and above, we evaluated the traffic exposure as a measure of speed and calculated it as the ratio of [length of (Highways + Major roads)/length of secondary roads] for the same catchments area as for the walkability index at both the 'origin (homes)' and 'destination (schools)' [21].

2.5. Analysis

The measure of 'health condition' ranged from 1 (underweight) to 4 (obese). Since they were measured as nominal variables, the appropriate approach was the use of multinomial logistic regression model [26,27]. Subsequently, we used four logistic regression models with normal weight as the base category to examine the relationships between perceptions of adolescents (model 1), their self-reported physical activity (model 2), the physical environment measured objectively in the GIS (model 3), and parents' perceptions (model 4) of the health conditions of Emirati adolescents. Each of these models build upon the previous models to examine the impacts of individual and all the factors in the full model with parents' perceptions (model 4). This incremental approach of analysis helped us to understand the impact of various factors gradually on the Emirati adolescents' health condition.

3. Results and Discussion

Based on the International Obesity Task Force (IOTF) categories, male and female students were grouped into four health categories. About 30% of females and 40% of males are either overweight or obese (Table 1). While close to two-thirds of emirate females were in the normal weight category, only half of their counterparts were in the normal weight category. This suggests male adolescents are at higher risk of various health concerns related to physical inactivity than females.

Table 1. Health condition based on reported BMI of Emirati male and female adolescents.

Health Code	Emirati Adolescents	
	Female	**Male**
1—Underweight	10 (7.5%)	9 (11.1%)
2—Normal Weight	83 (62.4%)	40 (49.4%)
3—Overweight	21 (15.8%)	8 (9.9%)
4—Obese	19 (14.3%)	24 (29.6%)
	133 (62.1%)	81 (37.9%)

3.1. Perception of Male and Female Adolescents

A two-sample T-test was conducted to test the differences in perceptions of the built environment by genders so as to assess which perceived the environment to be less suitable for walking and whether this difference was statistically significant. Of the 250 respondents, 158 were females and 92 were males. Responses indicate that, on average, male respondents perceived all the five built environment characteristics as hindrances or of more concern than females, and the differences were statistically significant (see Table 2). On average, street crossings were almost twice as much a concern for males than for female respondents. Subsequently, we checked if this difference was possibly due to exposure to the environment, i.e., walking to school, as reported by the male and female adolescents. However, the reported average walking distances for males and females was not significantly different, indicating that the concerns were directly about the built environment.

Table 2. Two-sample t-test to test the differences in the perception of built environment varies between male and female.

Built Environment Characteristics	Female (Obs. 158) Mean (SD)	Male (Obs. 92) Mean (SD)	t	*p* Value
Sidewalks	1.39 (1.67)	2.35 (2.52)	−3.24	0.000
Street crossing	2.04 (2.16)	4.00 (2.65)	−6.01	0.000
Traffic	1.68 (2.08)	2.58 (2.56)	−2.84	0.003
Safety	1.98 (2.07)	3.08 (2.65)	−3.43	0.000
Appeal	1.91 (1.86)	2.92 (2.63)	−3.27	0.000

This negative perception of the built environment by male students is contrary to other studies that found that females are more concerned with these types of constructs [16]. This may be explained by the fact that they are exceedingly aware of the increasing number of road accidents and fatalities in the UAE in which young male adults are the victims. Data from RoadSafetyUAE suggests that

> Young drivers below the age of 25 cause the majority of road accidents in the UAE and have the lowest levels of seat belt use . . . only 62 percent of drivers aged 18–24 always use their seat belt compared to 72 percent of overall drivers in the UAE, with 42 percent of young drivers not seeing the need to use them during short trips [28].

Currently, the UAE law permits those aged 17 to apply for a motorcycle license and those aged 18 for a car license. Maj. Gen. Al Zafein, a senior Dubai Police Officer who recently proposed the car driving age be reduced to 17, said that 'some have no choice but to get around by motorcycle, even though it is the more dangerous mode of transport . . . and some families have been forced to hire drivers for their children until they turn 18 and can legally drive themselves' [29].

Emirati men are also known to apply for their driving licenses earlier and drive more than their female counterparts. They also prefer sedentary indoor recreational activities such as computer games rather than outdoor sports [30,31]. Further studies that can assess the activities that both Emirati male and female adolescents pursue using objective measures such as accelerometers that can monitor the movement and capture the intensity of physical activities can provide more evidence to make more informed decisions to help students improve their health.

3.2. Parent and Adolescent Perceptions

A two-sample t-test was conducted to test the differences in parents' perceptions of the built environment compared to those of adolescents, both male and female. On average, parents' perceptions varied from adolescents on two constructs—sidewalks and street crossing (see Table 3). Parents reported higher averages on sidewalk concerns and lower averages over street crossing in comparison to the children. However, traffic, safety, and appeal of the environment were not significantly different between parents and adolescents.

Table 3. Two-sample t-test to test the differences in the perception of built environment vary between children and their parents.

Built Environment Characteristics	Parents (Obs. 151) Mean (SD)	Children (Obs. 250) Mean (SD)	t	*p* Value
Sidewalks	2.14 (1.35)	1.74 (2.07)	−2.06	0.020
Street crossing	2.25 (2.22)	2.76 (2.52)	2.15	0.016
Traffic	2.03 (2.12)	2.01 (2.30)	−0.09	0.463
Safety	2.23 (2.36)	2.39 (2.36)	0.74	0.227
Appeal	2.28 (1.97)	2.28 (2.23)	−0.02	0.509

Parents in general are more protective of their wards, which could invariably affect their perceptions of the built environment more negatively than children's perceptions. Given this, it was surprising to find that parents reported lesser concerns on average about the street crossing in comparison to their children. While about 40–50% of adolescents were concerned about the width of the street with marked crosswalks, only about 30% of the parents were concerned about the same. While parents expressed a preference for the presence of a guard at street crossings, the adolescents were keener on having a marked pedestrian crossing to help them cross the street.

3.3. The Determinant of Adolescent Health Condition

Multinomial logistic regression analyses were conducted to find the determinants predicting Emirati adolescents' health conditions (see Table 4). The first or the base model was built by inputting adolescents' demographic characteristics (i.e., age and gender) and perceptions of the built environment characteristics (i.e., sidewalk, street crossing, traffic, safety, and appeal).

The second model built upon the base model also included adolescents' self-reported levels of physical activity (PA). The third model assessed the impact of the objective measures of walkability index and traffic exposure, while the full model included parents' perceptions of the built environment characteristics. While the R-square for the multinomial regression output changed in log-likelihood from the intercept-only model (7%) to the four models with the full model reporting 40%, it cannot be interpreted the same way as a linear regression model, wherein the higher the R-square value the better. However, improved log-likelihood is generally accepted for comparison of models [32], indicating the full model better than the intercept-only model.

While the results of all four models are presented, the full model is explained in detail for its implications in determining the health conditions of adolescents in UAE. The results from all four models indicate that the odds that adolescents who have higher concerns with street crossing ($p < 0.05$) would be underweight was 2.2 times higher than being normal weight. However, the odds that they would be underweight decreased by three times if they were physically active, while being overweight or obese were not statistically significant. In addition, the odds that the male adolescent would be either underweight or obese increased by 2.5 times and about 20 times, respectively, over those of their female counterparts ($p < 0.05$).

The levels of physical activity reported similar results across the three models. Results indicate the higher the levels of physical activity, the lesser are the odds that the adolescent would be underweight in comparison to being normal weight. This suggests that physical activity can not only mitigate the likelihood of being overweight or obese but can help reduce the likelihood of an adolescent being underweight.

The objective assessment of the built environment reported an interesting relation with the health condition of the adolescents. The exposure to traffic at the destination, i.e., the school, reduces the odds that adolescents would be overweight by eight times in comparison to being normal weight. However, exposure to traffic at origin, i.e., the adolescent's home, increases the odds by about four times (full model) that adolescent would be overweight or obese in comparison to being normal weight. This indicates that higher exposure to traffic near the adolescent's home tends to negatively impact the health condition of the adolescent, which is similar to other studies [33]. However, with an increase in exposure to traffic near schools, the odds that adolescents would be negatively impacted reduces. This is surprising but could be because of the limited number of schools (only six) sampled. Furthermore, opportunities to participate in PA at schools may negate the effects of exposure to traffic. Future studies may be conducted to understand the nuances of how transportation policies around different schools (public and private) and mandatory physical training class periods in schools may affect these outcomes.

Table 4. Multinomial logistic regression of health condition of adolescents.

Variables	Adolescent Characteristics and Perception			Adolescent Physical Activity			Objective Built Environment			Parent Perception		
Base Case: Normal Weight	**Underweight**	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**
Age (C)	0.326	−0.179	0.174	0.346	−0.185	0.181	0.411	−0.296	0.141	0.429	−0.364	0.102
Sex (Male)	0.198	−0.358	0.807 ***	0.372	−0.294	0.836 ***	0.863	−0.363	1.399 **	2.575 **	0.453 ***	19.462 *
Perception of sidewalk (C)	0.113	0.104	0.090	0.121	0.104	0.089	−0.032	0.160	0.068	0.109	0.193	-0.467
Perception of Street Crossing (C)	0.356 ***	0.057	−0.005	0.360 ***	0.051	0.002	0.470 ***	0.009	0.110	2.223 **	−0.119	-0.077
Perception of Traffic (C)	0.115	0.136	−0.043	0.035	0.110	−0.060	0.130	0.220 [a]	−0.012	−0.783	0.446 ***	0.151
Perception of Safety (C)	−0.221	−0.038	−0.050	−0.197	−0.032	−0.043	−0.245	0.018	−0.133	−0.828 ***	−0.050	0.137
Perception of Appeal (C)	−0.157	−0.097	0.156	−0.139	−0.092	0.163	−0.196	−0.245	0.098	−1.681	−0.036	0.416 [a]
Levels of Physical Activity				−0.473 ***	−0.240	−0.143	−0.635 ***	−0.246	−0.117	−3.193 **	−0.036	0.056
Walkability Index at Origin							−0.371	0.228	−0.038	−2.683 **	−0.632	−1.081 ***
Walkability Index at Destination							0.299	0.635	0.391	−0.252	2.160 ***	13.070 *
Traffic Exposure at Origin							−0.697	1.485	1.443***	−2.449	4.066 ***	3.950 *
Traffic Exposure at Destination							−0.739	−8.063 ***	−1.051	−0.904	−13.900 ***	−55.98 *
Perception of Traffic (P)										0.435 [a]	−0.021	−0.010
Perception of Street-Crossing (P)										0.054	−0.642 ***	−0.308
Perception of Safety (P)										−0.260	0.387	0.124
Perception of Appeal (P)										0.458	−0.124	−0.036
Obs	213			213			175			105		
Wald Chi2 (21)	42.10			58.63			70.37			1981.44		
Prob > chi2	0.0041			0.0001			0.0005			0.000		
df	24			27			39			51		
Psuedo R2	0.070			0.081			0.163			0.404		
AIC	495.91			492.502			409.350			237.330		
BIC	575.581			583.257			532.777			372.682		

[a] $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; (C)—Children; (P)—Parent.

Better walkability at origin (homes) decreases the odds of adolescents being obese, while better walkability at destination (school) increases the odds of adolescents being overweight (by twice) or being obese (by 13 times) in comparison to being normal weight. In other words, a walkable environment around the schools does not help school-going adolescents become healthier. This is an unexpected outcome and contrary to most studies. It may be the effect of several factors combined, including the siting of the school on a major thoroughfare and government policies restricting students from walking on roads that allow vehicles to travel at speeds higher than 40 km. Locating schools away from major thoroughfares and close to local roads has been recommended by studies to increase the safety, accessibility, and ability to walk to schools [34].

Increased concerns with sidewalk increased the odds of adolescents being underweight, while increased concerns with traffic increased the odds of adolescents being obese. However, increased concerns with safety reduces the odds of the adolescents being underweight in comparison to being normal weight, indicating that, as perception of safety increased, the odds of adolescents being underweight decreased. While it can be speculated that, with higher perception of safety of the built environment, adolescents are engaged in outdoor activity that increased their food intake, leading to lesser chances of being underweight, the built environment factors that relate to being underweight are a less explored topic and will need further research to provide insight on this relation. Another topic of future investigation would be to understand why parents with higher concerns about the street crossing associated with lower odds of their children being overweight ($p < 0.05$) in comparison to being normal weight, which is contrary to assumption.

3.4. Predicting Probability of Health Condition

The marginal effect of levels of physical activity on health conditions were estimated. Table 5 reports that the probability of an adolescent being underweight is 13.4% and 6.4%, given that they report sedentary and low levels. Hence, it is important to propose specific policies to encourage higher levels of physical activity not only to deal with overweight or obese adolescents but also to preempt an adolescent from becoming underweight.

Furthermore, the probability of an adolescent being overweight or obese is significantly related to sedentary, low, and moderate levels of physical activity. However, the probability of adolescents being overweight and obese when engaged in vigorous PA is about 13% and 20%, respectively, while the rest of the predictors are set to their mean values. This could indicate the influence of improper diet, psychological factor or genetics [35], or even pseudo-opinions of the adolescents when self-reporting. Although outside the scope of this study, future studies to assess these factors could provide more insight.

Table 5. Marginal effect of activity levels on health conditions.

Levels of Activity	Health Condition of Adolescents		
	Underweight	Overweight	Obese
Sedentary	0.134 * (0.063)	0.248 *** (0.076)	0.303 *** (0.087)
Low	0.064 * (0.026)	0.106 ** (0.037)	0.136 *** (0.041)
Moderate	0.053 (0.029)	0.127 ** (0.049)	0.232 *** (0.062)
High	0.094 (0.099)	0.000 ** (0.000)	0.073 (0.072)
Vigorous	0.018 (0.018)	0.129 ** (0.056)	0.199 ** (0.065)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4. Implications and Conclusions

In a 2018 study, UAE scored an F on the levels of physical activity and a C- on sedentary behavior in the Global Matrix 3.0 physical activity report card grades for children and youth [36]. A study of two private schools in the Emirate in 2019 (prepandemic climate) found that only 9 percent of girls and 27 percent of boys did 30 min of physical activity a day [37]. These reports and findings from our study suggest an urgency in involving school officials, parents, and students from both public and private schools in the UAE in

making concerted efforts to increase the participation of children and youth in physical activities so as to ensure their good health.

As with all studies, this study also has its limitations. Firstly, our sample of schools is rather small and only has one private school, which may affect the generalizability of our study. Secondly, commensurate to the expertise of the research team in sustainable development and environmental design, we adopted a selection of factors simply focused on the built environment that could be potentially modified or enhanced to increase PA among UAE youth. However, a more holistic approach that can explore the lifestyle choices of Emirati youth is essential to better distinguish between determining, supporting, and enhancing factors of PA. Despite these limitations, our study has its merits, as outlined below.

4.1. Implications for Built Environment

In general, the built environment was perceived as not being conducive to walking, by both female and male adolescents. They had major concerns with street crossings due to the width of streets being too narrow and unmarked crosswalks. Within the construct of safety, they were concerned about the density of traffic and unsafe driving behavior on roads abutting their schools and homes. Adopting novel street design approaches such as the introduction of 'road diets' with curb cuts at intersections with textured crosswalks, a crossing island, and lane-narrowing options can improve perceptions of safety and reduce concerns related to street crossings. Studies report such interventions can reduce road crashes by about 6–18.8% [38].

Both traffic exposure and walkability around the homes of the adolescents have an impact on their health conditions. A better walkable environment with a higher land-use mix and density can encourage more walking [39,40] and reduce the chances of being underweight or obese adolescents. The Department of Urban Planning and Municipalities of Abu Dhabi (ADPM) have suggested implementing the Urban Street Design Manual projects in Al Ain with special consideration to the needs of pedestrians [39]. Implementation of this approach in core residential areas (trip origins) can reduce vehicle speeds, cut-through traffic, and general traffic noise. Additionally, reducing speed limits on major roads, especially those designated as school routes, may encourage walking.

In Abu Dhabi, the main concern is over the policies surrounding the built environment that make it hard to walk to school [41]. ADEK and ADPM may adopt transformative strategic options to promote active commuting to school as the primary mode of transportation. For example, the State of California in the USA has enhanced traffic safety along school routes by widening crosswalks and investing in sidewalk improvements, which have led to significantly greater walking or biking by children [42].

4.2. Implications for Health of Adolescents

A study by Al-Haddad et al. [3] reported that both males and females in the UAE tend to be about twice as likely to be overweight compared to international standards. In this study, about 10% males were more obese and overweight than females adolescents. Several sociocultural and behavioral factors specific to the region could be attributed to this difference. Culturally, males are the majority of the workforce in the UAE and are engaged in driving more than women. About 75 percent of all trips in the emirate of Abu Dhabi is made by males [43]. Studies indicate a high correlation of driving behavior and obesity [44] and sedentary behavior as one of the major causes of the obesity epidemic in males [45]. Creating opportunities such as funding more soccer, basketball, or cricket clubs, which are popular sports in the region and have huge fan following, within neighborhoods or in schools with a directive by the government will inspire the youth to engage in more outdoor activities.

Another less addressed issue with health outcomes is the assessment and impact of some adolescents being underweight [22]. While a key cause could be malnutrition, others could include poor dietary habit, fatigue, emotional trauma, genetics, psychological

factors, and smoking. Research suggests using 'effective public health programs that can simultaneously promote a healthy lifestyle, improve diet quality, and address both undernutrition and chronic disease' [34]. Health policies that regulate dietary intake both at school and at home need to be promoted. Recently, schools in Abu Dhabi have restricted the stocking of high-calorie foods for purchase at schools. Extending that by providing good dietary plans for students in schools can regulate this further and provide the necessary support to curb the issue of being underweight amongst adolescents. Additionally, regular psychological counseling may be provided to youth at schools to combat emotional eating disorders such as 'anorexia' or 'bulimia'.

4.3. Implications for Enhancing Physical Activity: Planning and Policy

The school environment can provide 'quality physical education and supportive environment for a long-lasting healthy and active lifestyle' [46]. Health and physical literacy at schools can provide needed knowledge, motivation, and engagement in physical activities. Control competence allows self-directed structuring and pacing of physical activity, which has shown to be more effective [47]. ADEK's policies to actively engage schools to develop control competence approaches for children and adolescents in school can instill PA behaviors that could last until adulthood.

Outside the school environment, the physical environment around the homes of adolescents can provide opportunities for engagement in an active lifestyle. Emirati housing communities lack sizeable open play areas and mixed use development to provide opportunities for after-school activities [48]. Small-area planning approaches such as Transit-Oriented Development (TOD) or Neighborhood Planning Unit (NPU) that incorporate better connectivity, land use mix, and open area planning for Emirati housing neighborhood needs to be proposed. By doing so, the Abu Dhabi Department of Planning and Municipality can enhance the accessibility within these neighborhoods [49]. In addition, 'compact' urban fabrics increase opportunities for social interactions and sustain alternative modes of transportation such as cycling, walking, and mass transit. Emirati neighborhoods for several decades have been designed as low-density developments with no diversity in land use. For these reasons, neighborhood designing requires an overhaul to include new ideologies such as compactness, connectivity, diversity, and proximity to connect people with people and people with their destinations more easily.

The street design manual of Abu Dhabi should develop street sections to enhance accessibility and connectivity to schools from residences. A street section that includes a wide sidewalk and bike lanes, with minimum lane width and lower speed limits, needs to be considered for inclusion in the Abu Dhabi Street Manual. Furthermore, alternative approaches such as pedestrian bridges for students to circumvent major roads with high speed to reduce exposures to high traffic should be incorporated in the design manual. In existing neighborhoods, retrofitting and improving alleys' physical conditions and appearances could also enhance their use and thus support walkability. Recommended physical improvement plans include paving, landscaping, and upgrading lighting to promote walking. Such improvements may be particularly helpful in suburban neighborhoods, where alleys are often unpaved, not utilized, improperly lit, and obstructed by debris and vegetation [50]. Although it is important to improve the environment to increase the physical activity levels, it is also important to increase the awareness of the benefits of physical activity among parents. A recent study stated that, to enhance the ability to engage in physical activity, it is important to improve the built environment and raise awareness by educating the parents [51].

The outcomes of this study provide implications to improve the overall health of adolescents in Abu Dhabi and may be extrapolated to other schools in the UAE. Furthermore, it is also relevant to major cities in the Middle East that have similar sociocultural, topographic, and demographic characteristics. They can implement similar approaches to enhance the health conditions of their youth, as well. This can help inform better health and education policies to achieve three of the interconnected UN Sustainable Development

Goals (SDGs), namely good quality health and well-being, quality education, and gender equality, that the UAE strives to achieve.

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Institutional Review Board Statement: The study was approved by the Abu Dhabi Department of Education and Knowledge (ADEK). The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Khalifa University (protocol code H17-005 on 23 August 2017).

Informed Consent Statement: Consent forms were signed by the representatives of each study school. Signed approval was also obtained from parents for their own participation and permitting the participation of their children in the study. Only students who received approvals from their parents were administered the survey.

Data Availability Statement: The ADEK approvals do not permit sharing of the data with any third party and restricts us from use and distribution of the same without their permission, given the privacy rules in the United Arab Emirates.

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