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Associations between Environmental Features and Physical Activity in Youth.

A presente dissertação foi escrita para a obtenção do título de Mestre no âmbito do curso de Mestrado em Atividade Física e Saúde.

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Palavras-chave: PHYSICAL ACTIVITY, ENVIRONMENT, CHILDREN, ADOLESCENTS

“Lack of activity destroys the good condition of every human being, while movement and methodical physical exercise save it and preserve it. “

Plato

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Resumo

A falta de atividade física (AF) durante a infância e adolescência é uma preocupação de saúde pública. Vários fatores podem influenciar o comportamento da AF nos jovens incluindo o envolvimento que os rodeia.

Nesta tese apresentam-se dois artigos científicos: uma revisão sistemática de estudos (paper I) cujo objetivo foi perceber quais as características do envolvimento que são associadas positivamente com a AF das crianças. Para o segundo artigo, procurou-se verificar se a AF (passos/dia) está associada a determinantes do envolvimento que possam, eventualmente, promover o caminhar e a AF em geral nos adolescentes Açorianos (paper II).

Numa primeira fase de revisão, foram encontrados vinte e oito estudos que estudaram a associação entre a AF e as determinantes do envolvimento em crianças dos 3 aos 12 anos de idade. O estudo transversal (paper II) contou com 948 adolescentes Açorianos dos 15 aos 18 anos de idade que participaram no Estudo de Atividade Física e da Saúde dos Açorianos II em 2008. A AF foi medida objetivamente através de pedómetros e as determinantes ambientais com um questionário.

Os resultados, através dos vários estudos incluídos na revisão, demonstraram que os passeios e as ciclovias foram associados positivamente com a AF das crianças. A segurança, o trânsito e o tempo continuam a ter associações inconsistentes pelo que ainda não se sabe a influência que desempenham na atividade física. Quanto ao estudo transversal, a análise de regressão demonstrou que os adolescentes com uma perceção geral positiva em relação ao transporte tinham 44.2% mais probabilidade de serem classificados como ativos do que aqueles com uma perceção geral negativa.

Estudos futuros relativos a associações entre a AF e as perceções do envolvimento em crianças e adolescentes devem considerar o uso de medidas objetivas da AF, uma vez que este tema tem sido bastante abordado nos últimos anos.

Palavras-chave: ATIVIDADE FÍSICA, ENVOLVIMENTO, CRIANÇAS, ADOLESCENTES

Abstract

The lack of physical activity (PA) during childhood and adolescence is a public health concern. Several factors may influence PA behavior in youth including the environment that surrounds them.

In this thesis we included a systematic review of studies (paper I) aimed to understand which environmental features were associated with children's PA; and a second article (paper II) aimed to verify if PA behavior (steps/day) was associated with environmental features that may promote walking and PA in Azorean adolescents.

In the systematic review (paper I), we considered twenty-eight studies that have fulfilled the selection criteria (studied the association between environmental features and PA in children of 3 to 12 years old). The cross-sectional study (paper II) comprised 948 Azorean adolescents aged 15 to 18 years who participated in the Azorean Physical Activity and Health Study II in 2008. PA was objectively measured with pedometers and environmental features with a questionnaire.

Results, among the several studies included in the review, showed that sidewalks and bike lanes were always positively associated with children's PA. Safety, traffic and the weather continue to have inconsistent associations for what remains to be seen regarding the influence they play in PA. As to the cross-sectional study, the regression analysis reported that adolescents with a positive overall perception in the transport dimension were 44.2 % more likely to be classified as active, than those with a negative overall perception.

Future studies on the associations between environmental perceptions and PA in youth should consider the use of objective measures of PA, once this subject has been widely discussed in the last few years.

Keywords: PHYSICAL ACTIVITY, ENVIRONMENT, CHILDREN, ADOLESCENTS

Résumé

L’absence d'activité physique (AP) durant l'enfance et l'adolescence est une préoccupation de santé publique. Plusieurs facteurs peuvent influencer le comportement de l’AP chez les jeunes, y compris l'environnement qui les entoure.

Dans cette thèse, nous avons inclus un examen systématique des études (article I) visant à comprendre comment les facteurs environnementaux ont été associés à l’AP chez les enfants; un second article (article II) permettant de vérifier si le comportement de l’AP (nombre de pas/jour) était lié à des caractéristiques environnementales pouvant promouvoir la marche et l’AP chez les adolescents des Açores.

Dans la revue systématique (article I), nous avons examiné vingt-huit études ayant rempli les critères de sélection (étudier l'association entre les caractéristiques environnementales et l’AP chez les enfants de 3 à 12 ans). L'étude transversale (article II) comprend 948 adolescents des Açores âgés de 15 à 18 ans ayant participé à l'Étude de l’Activité et de la Santé des Açoriens II en 2008. L’AP a été mesuré objectivement avec des podomètres et les caractéristiques environnementales à l'aide d'un questionnaire.

Les résultats ont montré que, parmi les différentes études incluses dans l'analyse, les trottoirs et les pistes cyclables ont toujours été concluants pour l’AP des enfants. La sécurité, le trafic et la météo continuent à être incompatibles en ce qui concerne l'influence qu'ils jouent dans l’AP. Quant à l'étude transversale, l'analyse de régression a indiqué que les adolescents ayant une perception globalement positive concernant la dimension de transport étaient 44,2% plus susceptibles d'être classés comme actifs que ceux ayant une perception globalement négative.

Des futures études sur les associations entre les perceptions de l'environnement et de l'AP chez les jeunes devraient envisager l'utilisation de mesures objectives de l’AP, une fois que cette thématique a été largement discutée durant les dernières années.

Mots-clés: ACTIVITÉ PHYSIQUE, ENVIRONNEMENT, ENFANTS, ADOLESCENTS

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Paper I

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Lista de Abreviaturas:

BMI – Body Mass Index
CI – Confidence Intervals
GIS – Geographical Information System
NEWS-Y – Neighborhood Environment Walkability Scale for Youth
OR – Odds Ratio
PA – Physical Activity
PAQ-C – Physical Activity Questionnaire for Older Children
SD – Standard Deviation
SES – Socioeconomic Status
SOPLAY – System for Observing Play and Leisure Among Youth
SR2S – Safe Routes to School

1. Introduction

1. Introduction

The lack of physical activity (PA) during childhood and adolescence is a public health concern as it is associated with both short- and long-term health problems (USDHHS, 2008; WHO, 2010). Compared to previous generations, children are now spending less time playing outside (Karsten, 2005; Tranter & Doyle, 1996) and more time in sedentary activities at home (Karsten, 2005; Tandy, 1999). To reinforce this idea, in 1969, 40.7% of U.S. children walked to school. Today, approximately 12.9% (McDonald, 2007) walk to school and in some areas the number is as low as 5% (Sirard, Ainsworth, McIver, & Pate, 2005).

In order to prevent such low levels of PA, youth should start engaging in regular PA. Thus, promoting regular PA is becoming a priority in public health in developing and developed countries (Guthold, Ono, Strong, Chatterji, & Morabia, 2008; WHO, 2004).

Several factors may influence PA behavior in children and adolescents (Van Der Horst, Paw, Twisk, & Van Mechelen, 2007). In the last few years, a growing body of evidence has been accumulated on activity-friendly environmental features that may influence PA behavior in youth (Sallis & Glanz, 2006) however, there are few studies in Portuguese children and adolescents so understanding and modifying the environmental context where the activity occurs, may offer an opportunity for enhancing PA and health (King, Stokols, Talen, Brassington, & Killingsworth, 2002; TRB & IMNA, 2005).

This master thesis will, therefore, report which environmental features are most common in children and adolescents and how that will influence their PA levels. To do so, this thesis is divided into two different papers. The first is a systematic review of twenty-eight studies where we sought to find and comprehend which environmental features were mostly positively associated with children's PA. The second is an original research article where we aimed to verify if PA behavior (steps/day) was associated with environmental features that may promote PA and walking in Azorean adolescents.

2. Papers

Paper I

Oliveira, A., Santos, R., Moreira, C., Abreu, S. & Mota, J. (2012). **Environmental determinants of physical activity in children: a systematic review.**

Environmental determinants of physical activity in children: a systematic review

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Abstract

Background: The lack of physical activity (PA) in children is an important health risk factor. Previous studies have shown that some environmental features may be associated with PA levels.

Methods: Twenty-eight studies that assessed association between the environmental features and physical activity among children (ages 3 to 12-years) and fulfilled selection criteria were systematically reviewed.

Results: Results across the various studies showed that facilities and parks/playgrounds are mostly positively associated with children's PA. Sidewalks and bike lanes were positively associated to PA in all studies. Safety, traffic and weather showed inconsistent associations with children's PA.

Conclusions: Beginning to understand which environmental features contribute more to PA in children can lead to increased levels of PA.

Background

The lack of physical activity (PA) during childhood is an important health risk factor (WHO, 2010). Studies have shown that regular PA reduces and prevents obesity among children (Blair & Brodney, 1999; DeLany, Bray, Harsha, & Volaufova, 2002), and provides several benefits including improved physical (Andersen et al., 2006) and mental (Biddle, Gorely, & Stensel, 2004) health. Comparing with previous generations, children now are spending less time playing outside (Karsten, 2005; Tranter & Doyle, 1996) and spending more time in sedentary activities at home (Karsten, 2005; Tandy, 1999). Therefore, PA promotion is a public health priority (WHO, 2004).

There is a growing body of evidence that activity-friendly environmental features may influence PA in youth (Sallis & Glanz, 2006). Therefore, understanding and modifying the environmental context where the activity occurs, may offer an opportunity for enhancing PA and health (King et al., 2002; TRB & IMNA, 2005).

To the best of our knowledge, only one study, published in 2006, reviewed environmental perceptions related to PA in children. In that review, Davison et al. (Davison & Lawson, 2006), found that the presence of sidewalks in children's neighborhood, fewer uncontrolled intersections, lower traffic density and availability of facilities were positively associated with higher PA levels in children.

Since this review, the literature on environmental features and PA in children has been abundant and therefore it is of important to summarize those findings.

In this context, the aim of this study is to review systematically the literature on environmental determinants of PA in children between January 2007 and January 2012.

Methods

Search Strategies and databases searched

This systematic review consisted of a search of published literature in the English and French language. Databases that were searched included PubMed, SPORTDiscus and PsycINFO. A search using the same keywords as MESH terms in all sources was performed. The main strategy used was the combination of the keywords: environment, physical activity and children between January 2007 and January 2012. Previous reviews with children and adolescents were also examined for further research.

Inclusion/exclusion criteria

The present review was concerned about the amount and type of environmental features or attributes that could influence PA levels in children. Therefore, the studies were selected if: (i) they had been published between January 2007 and January 2012; (ii) they included a sample of children aged between 3 to 12 years; (iii) they had either one method to measure environmental perceptions and PA or both; (iv) they had at least one association between PA and the environment. Studies were excluded when (i) the results were not reported separately for children, in the studies included children and adolescents; (ii) the sample of the study consisted of children with disabilities; (iii) when environmental features consisted only of school facilities or playgrounds.

Systematic review process

Figure 1 shows the search and retrieval process. The number of references searched in each database were 275 (PubMed), 6 (SPORTDiscus), and 30 (PsycINFO). After removing all duplicates, 300 references were found of which 56 were identified as possible results for this review by title and abstract screening. Full texts of 55 papers were retrieved. Of those, six were reviews (three systematic and three comprehensive reviews) and in consequence they were excluded; their reference lists were reviewed and potential results were found. Twenty-one possible results were excluded then due to the combination

of results between children and adolescents, the age of children was different because in some of the papers the participants' age was not specified and they did not have associations between PA and the environment. Ultimately, twenty-eight published studies were included in this review.

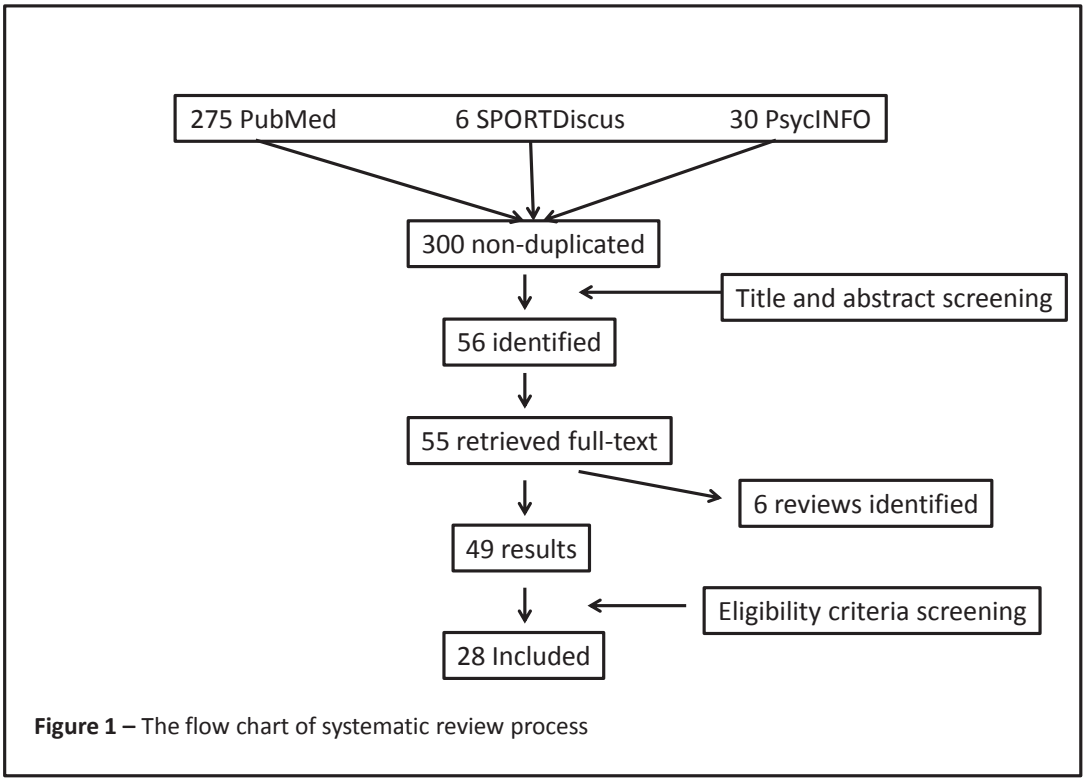

Figure 1 – The flow chart of systematic review process

Coding of results

In the present review, studies were selected by their association between PA and the environmental features. The association reported in Table 1 was coded with the following signs: +, - and ø. + stood for a positive association between PA and the environment; - indicated a negative association between PA and the environment; ø was for when there was no association found. For safety and traffic the signals of - and + should be interpreted as the following: (i) – means that lower safety was associated with lower PA levels; and + means that higher safety was associated with higher PA levels; (ii) – means that lower traffic or traffic considered not to be safe was associated with lower PA levels; and + indicated a positive association between lower traffic or traffic considered to be safe was associated with higher PA levels.

Table 1 - *Child studies categorized by author, sample size, country, measurement of environmental perceptions and PA, facilities, parks/playgrounds, safety, traffic, sidewalks, bike lanes and weather*

Authors	Study Design	Sample Size (N, age)	N Boys	N Girls	Country	Method to measure environmental perceptions	Method to measure physical activity	Facilities	Parks/ Playgrounds	Safety	Traffic	Sidewalks	Bike Lanes	Weather
Alton et al. (Alton, Adab, Roberts, & Barrett, 2007)	Cross-sectional	473 (9-11y)	250	223	United Kingdom	Questionnaire	Self-report	+		-	+/- (high walkers/low walkers)			
Borrestad et al. (Borrestad, Andersen, & Bere, 2011)	Cross-sectional	1339 (10-12y)	630	684	Norway		Self-report for children							+/ø (winter/spring, fall)
Bringolf-Isler et al. (Bringolf-Isler et al., 2008)	Cross-sectional	636 (6-10y)	323	313	Switzerland	GIS	Reported by parents			-	-			-
Carson et al. (Carson, Kuhle, Spence, & Veugelers, 2010)	Cross-sectional	3421 (9-11y)	1642	1779	Canada	Survey for parents	Self-report; PAQ-C; Parent proxy report		+	ø		+		

Carver et al. (Carver, Timperio, Hesketh, & Crawford, 2010)	Cross-sectional	170 (10-11y)	87	83	Australia	Survey for parents	Accelerometry		-		
Carver et al. (A. Carver, A. F. Timperio, & D. A. Crawford, 2008c)	Cross-sectional	188 (8-9y)	83	105	Australia	Reported by parents; GIS	Accelerometry	-	-	-	
Carver et al. (Carver, Timperio, Hesketh, & Crawford, 2009)	Longitudinal	170 (8-9y)	87	83	Australia	Reported by parents; GIS	Accelerometry	+		+	+
Carver et al. (A. Carver, A. Timperio, & D. Crawford, 2008a)	Cross-sectional	188 (8-9y)	100	88	Australia	Questionnaire for parents	Accelerometry		ø	-	
Crawford et al. (Crawford et al., 2010)	Longitudinal	301 (10-12y)	128	173	Australia	Reported by parents; GIS	Accelerometry	ø	ø	-/ ø (boys/girls)	
D'Haese et al. (D'Haese, De Meester, De	Cross-	696 (11-12y)	362	334	Belgium	NEWS-Y by parents;	Reported by			+	

Bourdeaudhuij, Deforche, & Cardon, 2011)	sectional					Routenet online router planner	parents							
de Vries et al. (de Vries, Bakker, van Mechelen, & Hopman-Rock, 2007)	Cross-sectional	422 (6-11y)	207	215	Netherlands	Observations	Diary	ø	-		-		+	
de Vries et al. (de Vries, Hopman-Rock, Bakker, Hirasing, & van Mechelen, 2010a)	Cross-sectional	448 (6-10y)	216	232	Netherlands	NEWS-Y	Diary	+	+	+	+	+		
Giles-Corti et al. (Giles-Corti et al., 2011)	Cross-sectional	1480 (11-12y)	702	778	Australia	GIS; Pedshed					+			
Harrison et al. (Harrison et al., 2011)	Cross-sectional	1794 (9-10y)	808	986	United Kingdom		Accelerometry							-
Holt et al. (Holt, Spence, Sehn, & Cutumisu, 2008)	Cross-sectional	168 (6-12y)			Canada	Drawing			+			+		

Hume et al. (Hume, Salmon, & Ball, 2007)	Cross-sectional	280 (10y)			Australia	Self-report; Survey for children	Accelerometry	+		+/- (boys/girls)				
Jones et al. (Jones, van Sluijs, Ness, Haynes, & Riddoch, 2010)	Longitudinal	3935 (11y)	1861	2074	United Kingdom		Questionnaire; Accelerometry							+
Panter et al. (Panter, Jones, Van Sluijs, & Griffin, 2010)	Cross-sectional	2012 (9-11y)	899	1113	United Kingdom	Questionnaire; GIS		ø		-	+		+	
Rodríguez et al. (Rodriguez & Vogt, 2009)	Cross-sectional	1897 (8-11y)	996	901	USA	Survey for children		-		+				
Roemmich et al. (Roemmich, Epstein, Raja, & Yin, 2007)	Cross-sectional	88 (8-12y)	44	44	USA	GIS	Accelerometry	+	+		+			
Rosenberg et al. (Rosenberg et al., 2009)	Longitudinal	116 (5-11y)	55	61	USA	NEWS-Y	Survey; Self-report	+	+	+	+	+	+	
Scott et al. (Scott,	Cross-	1367 (11-	-	1367	USA	Self-report;	Accelerometry	+						

Evenson, Cohen, & Cox, 2007)	sectional	12y)				GIS				
Smith et al. (Smith et al., 2010)	Cross-sectional	764 (7-9y)	384	380	Australia	Screen time reported by parents	Reported by parents	+		
Spengler et al. (Spengler et al., 2011)	Cross-sectional	2358 (≤10y)	1309	1049	USA		Direct Observation (SOPLAY)	+	+	
Timperio et al. (Timperio et al., 2008)	Cross-sectional	163 (8-9y)	90	73	Australia	GIS	Accelerometry		+ (boys)	
Veitch et al. (Veitch, Salmon, & Ball, 2008)	Cross-sectional	212 (8-12y)	105	107	Australia	Mapping; Survey		+	+	
Veitch et al. (Veitch, Salmon, & Ball, 2010)	Cross-sectional	187 (8-9y)	99	88	Australia	Survey for parents	Accelerometry		+	+
Zhu et al. (Zhu, Arch, & Lee, 2008)	Cross-sectional	1185 (4-11y)			USA	Survey for parents				-

GIS – Geographical Information System; PAQ-C – Physical Activity Questionnaire for Older Children; NEWS-Y – Neighborhood Environment Walkability Scale for Youth; Routenet online router planner – objectively determine the distance of the shortest route from each child's home to school; Pedshed – i.e., a ratio of the pedestrian network area to the maximum possible area within a defined distance based on Euclidian distance; SOPLAY – System for Observing Play and Leisure Among Youth.

For safety and traffic the signals of - and + should be interpreted as the following: (i) – means that lower safety was associated with lower PA levels; and + means that higher safety was associated with higher PA levels; (ii) – means that lower traffic or traffic considered not to be safe was associated with lower PA levels; and + indicated a positive association between lower traffic or traffic considered to be safe was associated with higher PA levels.

Results

We have identified a total of 28 publications that presented at least one association between PA and environmental determinants. All of the studies in Table 1 were published in the last five years. There were more publications in 2008 (Bringolf-Isler et al., 2008; Carver et al., 2008a; Carver et al., 2008c; Holt et al., 2008; Timperio et al., 2008; Veitch et al., 2008; Zhu et al., 2008) and 2010 (Carson et al., 2010; Carver et al., 2010; Crawford et al., 2010; de Vries et al., 2010a; Jones et al., 2010; Panter et al., 2010; Smith et al., 2010; Veitch et al., 2010). Similar amount of publications were found in the remaining years of study.

The vast majority of the studies used a cross-sectional design (24 of 28 studies).

The sample size of the different studies varied between 83 and 3935 participants.

Regarding study location, most studies were conducted in Australia (Carver et al., 2008a; Carver et al., 2009, 2010; Carver et al., 2008c; Crawford et al., 2010; Giles-Corti et al., 2011; Hume et al., 2007; Smith et al., 2010; Timperio et al., 2008; Veitch et al., 2008, 2010); USA (Rodriguez & Vogt, 2009; Roemmich et al., 2007; Rosenberg et al., 2009; Scott et al., 2007; Spengler et al., 2011; Zhu et al., 2008) and United Kingdom (Alton et al., 2007; Harrison et al., 2011; Jones et al., 2010; Panter et al., 2010).

Overall, the methods to measure environmental perceptions were mostly measured by GIS (Bringolf-Isler et al., 2008; Carver et al., 2009; Carver et al., 2008c; Crawford et al., 2010; Giles-Corti et al., 2011; Panter et al., 2010; Roemmich et al., 2007; Scott et al., 2007; Timperio et al., 2008) and reported by parents (Carver et al., 2009; Carver et al., 2008c; Crawford et al., 2010; Smith et al., 2010) .

After reviewing these perceptions, we sought to find which methods to measure PA were most used. Between those, it stood out accelerometry (i.e., 12 studies) followed by self-report (i.e., 4 studies).

Only three studies (Crawford et al., 2010; Hume et al., 2007; Timperio et al., 2008) reported differences between genders in the associations between PA and environmental features.

In relation to the environmental features or attributes associated with PA levels, both sidewalks and bike lanes were always positively associated with PA.

As it is shown in Table 1, the existence of facilities and parks/playgrounds in the neighborhood was compelling on its association with PA being in most studies positively associated. Even though safety and traffic are the two most studied environmental features their associations with PA levels are inconclusive. Bike lanes and weather are the environmental features less studied between those under study.

Availability of recreation areas and spending on recreational infrastructure

In ten out of fifteen studies, a significant positive association was identified between the availability and presence of recreation facilities nearby the neighborhood and children's PA. Of those ten, five studies did not specify the type of recreational facilities under study. In a study measuring environmental perceptions and PA, Hume et al. (Hume et al., 2007), found that friends' houses within easy distance were positively associated with PA. Similarly, Alton et al. (Alton et al., 2007) and Veitch et al. (Veitch et al., 2008) using samples from United Kingdom and Australia respectively, found that nearby shops or friends' houses in the neighborhood were positively correlated to children's PA. Among US samples, Scott et al. (Scott et al., 2007) reported that a greater amount of facilities for Basketball, as determined by objective assessment, were positively associated with PA levels in children and Spengler et al. (Spengler et al., 2011) found out that both Basketball and Tennis fields were positively associated with PA. In addition, Carver et al. (Carver et al., 2008c) and Rodriguez et al. (Rodriguez & Vogt, 2009) found a negative association between facilities outside the neighborhood environment and children's PA. Finally, no association was identified between facilities and

children's PA in three studies (Crawford et al., 2010; de Vries et al., 2007; Panter et al., 2010).

Proximity of parks and playgrounds

It was identified a significant positive association between the proximity of parks and playgrounds and children's PA in nine of ten studies. Among these nine studies, two of them, measuring subjectively environmental perceptions, found that nearby playgrounds were positively associated with children's PA (de Vries et al., 2010a; Holt et al., 2008). Furthermore, Timperio et al. (Timperio et al., 2008) reported that near playgrounds were only positively associated with boys' PA. Several studies (Carson et al., 2010; Roemmich et al., 2007; Rosenberg et al., 2009; Spengler et al., 2011; Veitch et al., 2008, 2010) showed that environmental perceptions were positively correlated with nearby parks and children's walking or cycling trips. Of those assessing children's PA, only two studies (Roemmich et al., 2007; Veitch et al., 2010) objectively measured PA with accelerometers.

One negative association was found between nearby playgrounds and children's PA. This association was due to the fact that it was a paved playground affecting negatively children's PA (de Vries et al., 2007).

Safety and neighborhood

A significant positive association between safety perceptions and PA was found in five of fifteen studies. Of these five, two (Rodriguez & Vogt, 2009; Veitch et al., 2010) reported that the perception of the neighborhood being safe was positively associated with PA in children. Rosenberg et al. (Rosenberg et al., 2009) and de Vries et al. (de Vries et al., 2010a) reported that the lack of criminal activities and the presence of pedestrian crossings, respectively, were positively associated with PA.

In a study by Hume et al. (Hume et al., 2007), they found a positive association between safety perceptions and PA in boys, however, it was also found a negative association for girls. Negative associations were found in seven of fifteen studies. Six (Alton et al., 2007; Bringolf-Isler et al., 2008; Carver

et al., 2010; Carver et al., 2008c; Hume et al., 2007; Zhu et al., 2008) of them were related to parental concerns about neighborhood safety. Panter et al. (Panter et al., 2010) found that the lack of streetlights was negatively associated with children's PA. Finally, no associations were found in three of fifteen studies. Of those, two (Carson et al., 2010; Crawford et al., 2010) referred safety concerns. Carver et al. (Carver et al., 2008a) did not find any association regarding pedestrian crossings and PA levels in children.

Traffic

Eight of fourteen studies found positive associations between traffic perceptions and PA in children. A good street connectivity was positively associated in three studies (D'Haese et al., 2011; Giles-Corti et al., 2011; Roemmich et al., 2007) in which two of them were measured by the NEWS-Y system. De Vries et al. (de Vries et al., 2010a) and Panter et al. (Panter et al., 2010) reported that traffic lights and density of roads, respectively, were positively associated with children's PA.

Two (Giles-Corti et al., 2011; Rosenberg et al., 2009) out of eight studies identified that the lack of traffic concerns in general, was positively associated with PA. Alton et al. (Alton et al., 2007) found that positive and negative traffic perceptions were associated to PA in high walkers and low walkers, respectively. Thus, it was found six negative associations in fourteen studies, three of which, were related to general concerns about traffic (Alton et al., 2007; Bringolf-Isler et al., 2008; Carver et al., 2008c). De Vries et al. (de Vries et al., 2007) reported that a negative perception of intersections was negatively associated with children's PA.

We found two studies (Carver et al., 2008a; Crawford et al., 2010) showing that the lack of traffic lights was negatively associated with PA. In the same study of Carver et al. (Carver et al., 2008a) what is interesting to see is that it was found a negative association between traffic lights and boys' PA but they did not find any association regarding traffic lights and girls' PA.

Presence of sidewalks and bike lanes

In this review, results supported that the presence of sidewalks and bike lanes in the neighborhood were strongly associated with children's PA. Only one study assessed both sidewalks and bike lanes (Rosenberg et al., 2009). In general, all studies subjectively measured environmental perceptions with the exception of the studies by Carver et al. (Carver et al., 2009) and Panter et al. (Panter et al., 2010) in which they used the Geographical Information System (GIS). Finally, only one study objectively assessed PA levels in children (Carver et al., 2009).

Weather

A significant positive association between weather and children's PA was identified in two of four studies. Although Jones et al. (Jones et al., 2010) reported that PA was positively associated in the summer, Borrestad et al. (Borrestad et al., 2011) found that even in winter, weather could influence positively PA levels in children. In the same study of Borrestad et al. (Borrestad et al., 2011), they did not find any association regarding PA in spring or in fall.

Harrison et al. (Harrison et al., 2011) reported that rainfall influence negatively 9-10 year old children's PA. Related to the same subject, Bringolf-Isler et al. (Bringolf-Isler et al., 2008) showed that bad weather conditions influence negatively the mode of travel of children.

Discussion

In this paper, we systematically reviewed research on associations between environmental features and children's PA. The most consistent pattern of findings was evident to sidewalks and bike lanes being always positively associated with PA, followed by facilities and parks which were mostly positively associated with children's PA. However, some environmental features as safety, traffic and weather were still inconclusive about their association with children's PA.

Results from previous studies examining facilities and children's PA showed that the proper equipment functioning and athletic facilities were associated with higher levels of PA (Fein, Plotnikoff, Wild, & Spence, 2004). However, in the study of Adkins et al. (Adkins, Sherwood, Story, & Davis, 2004), they reported that the perceptions of facilities were not associated with PA in girls. Comparing these results with the current review we can see that not much differs from what it was already knew. Environmental features are studied more often nowadays. To support this point of view, in the review by Davison et al. (Davison & Lawson, 2006), they found five studies assessing the proximity of parks and playgrounds and children's PA when at the present we found the double. Of those studies, only three were positively associated with children's PA. In the current review we found nine since 2007.

Findings are more consistent when it comes to safety, with more studies than before finding positive associations with safety and children's PA. Indeed in the review of Davison et al. (Davison & Lawson, 2006) most studies reported a null association between safety and children's PA. Parents and children have a tremendous concern regarding road safety (Mullan, 2003) and stranger danger (Carver et al., 2008c; Mullan, 2003; Veitch, Bagley, Ball, & Salmon, 2006). Effectively, this will always be under discussion because it is expected to find always negative and positive perceptions regarding safety and children's PA. Different parents and children have different perceptions, besides neighborhoods and the neighborhood environment are not all the same.

In contrast to safety, traffic concerns seem to have diminished. Before 2007 we found some studies regarding traffic and children's PA. The majority of

them (Gielen et al., 2004; Timperio, Salmon, Telford, & Crawford, 2005; Veitch et al., 2006) were negatively associated with PA in children. Currently, according to our results, traffic was more studied and the results reflect the opposite than before. Most of the studies found in our review showed that there are more positive perceptions of parents and their child regarding traffic and children's PA.

The perception of traffic being safe is enhancing PA levels in children as sidewalks and bike lanes. The association between traffic and sidewalks or bike lanes is worthy of discussion. In a previous review (Retting, Ferguson, & McCartt, 2003) it was reported that the presence of sidewalks as walking trails were protectors to safety of pedestrians in urban and residential places. In an intervention plan designed by Boarnet et al. (Boarnet, Anderson, Day, McMillan, & Alfonzo, 2005) called Safe Routes to School (SR2S) they showed children that pass through those constructs were more physically active. Concerning bike lanes, they have been studied equally over time however, for our age range we did not find any reference that influenced children's PA before 2007.

It seems that there is enough evidence that all of these factors are important influencing PA in children but one factor that cannot be forgotten is the weather. As the weather is the only feature studied that we cannot control it is interesting to see how it is associated with children's PA. Besides the fewer studies than now, they are consistent from our current data. Brodersen et al. (Brodersen, Steptoe, Williamson, & Wardle, 2005) found that the weather was positively associated in children's PA, though precipitation affected negatively girls' PA.

Limitations and Strengths

We acknowledge some limitations of our current review. To begin with, the keywords used to retrieve studies from existing literature may have not been accurate enough. The main outcome was overall PA, not enabling to determine the specific environmental correlates of specific physical activities. Some studies did not use objective measures for environmental perceptions and physical activity.

Although the few databases searched we managed to find a considerable amount of studies fulfilling the selection criteria.

Conclusions

The environment can give children the possibility to be more active. It is well known that it is not up to them if they want to be physically active nevertheless they have that opportunity. There will always be external influences that can influence children's PA level, such as parents. Therefore, they will only allow their child to be active, especially outdoors, if there exists proper conditions once safety is a major concern. If children are not safe, they will not be physically active. Although this is a careful subject it is good to remember that children cannot be always excluded from their activities because danger will exist forever, no one can prevent it. It is important to retain that parents should allow their child to play knowing the risks involved because if not, children will never have the perceptions needed that surround them (environment) and will never have the ability to do anything.

In spite of the fact obesity levels are growing all over the world, these perceptions have been more studied and now, there is a lot more of positive evidence regarding PA and the environment. Facilities and parks/playgrounds have been most studied over time being positively associated with PA in the majority of studies. The presence of sidewalks and bike lanes should be targets of special attention because in most of the studies it was found that it was always positively associated with PA. Despite of the fact that those environmental features previously mentioned have been easily associated with PA, there are still inconclusive features as safety, traffic and weather regarding its association with PA. In these, only traffic concerns have diminished which reflects the idea that the environment has been more studied than some years ago.

Beginning to understand which environmental features contribute more to PA in children can lead to increased levels of PA.

Perspectives

Future studies on the associations between environmental perceptions on objective measures and PA levels in children should consider the use of objective measures of PA.

Paper II

Oliveira, A.; Mota, J.; Moreira, C.; Vale, S.; Silva, P.; Abreu, S.; Moreira, P. & Santos, R. (2012). **Adolescents' perception of environmental features and its association with physical activity: results from de Azorean Physical Activity and Health Study II.** ***Journal of Physical Activity and Health. (under review)***

Adolescents' perception of environmental features and its association with physical activity: results from de Azorean Physical Activity and Health Study II

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Abstract

Background: The aim of the present study was to verify if physical activity (PA) behavior (steps/day) was associated with environmental features that may be able to promote PA and walking in a sample of Portuguese adolescents living in the Azorean Archipelago.

Methods: The sample comprised 948 adolescents aged 15-18 years (543 girls) from the Azorean Physical Activity Health Study II. PA was objectively measured with pedometers. Participants were classified as active if they belong to percentile 75th (by age and gender) or more. Environmental perceptions were assessed with a questionnaire. Binary logistic regression analyzed relationships between PA and environmental perceptions controlling for age, body mass index, gender and socioeconomic status.

Results: Regression analysis showed that participants with a positive overall perception in the transportation dimension were 44.2% (OR=1.442, p=0.025) more likely to be classified as active, than those with a negative overall perception. No significant results were found for safety, aesthetics and facilities dimensions.

Conclusions: A positive overall perception of the transportation dimension was positively associated with PA in Azorean Adolescents. Future health promotion strategies aimed to increase PA in this population should consider the environmental features that are associated with PA levels.

Introduction

The lack of physical activity (PA) during childhood and adolescence is a public health concern as it is associated with both short- and long-term health problems (USDHHS, 2008). Compared to previous generations, children are now spending less time playing outside (Karsten, 2005; Tranter & Doyle, 1996) and more time in sedentary activities at home (Karsten, 2005; Tandy, 1999). To reinforce this idea, in 1969, 40.7% of U.S. children walked to school. Today, approximately 12.9% (McDonald, 2007) walk to school and in some areas the number is as low as 5% (Sirard et al., 2005).

In order to prevent such low levels of PA, it is necessary to take action. This means that people should engage in regular PA. Therefore, promoting regular PA is becoming a priority in public health in developing and developed countries (Guthold et al., 2008; WHO, 2004).

Several factors may influence PA behavior in children and adolescents (Van Der Horst et al., 2007). In the last few years, a growing body of evidence has been accumulated on environmental factors that may influence PA behavior in children and adolescents. The literature has shown that PA in youth has been positively associated with access to facilities (Ball, Timperio, & Crawford, 2006; Davison & Lawson, 2006; Giles-Corti, Kelty, Zubrick, & Villanueva, 2009; Hume, Salmon, & Ball, 2005; Maas, Verheij, Spreeuwenberg, & Groenewegen, 2008; Smith et al., 2010), parks/playgrounds (Davison & Lawson, 2006; Farley et al., 2007; Hume et al., 2005; Larsen et al., 2009; Maas et al., 2008; Veitch et al., 2010), sidewalks/bike lanes (Carver et al., 2009; Davison & Lawson, 2006; Health, 2009; Maas et al., 2008), and safety (Cohen et al., 2009; Giles-Corti et al., 2009; Veitch et al., 2010).

Quantifying PA has never been easy. The current recommendation is to measure PA objectively with pedometers or accelerometers due to their precision and validity (Freedson & Miller, 2000; Moreau et al., 2001). The use of pedometers to quantify PA has been growing in the last decade. Pedometers are an important tool to measure PA because they are accurate, inexpensive, can be used in large samples and make measuring PA volume quite easy.

To the best of our knowledge, only one study has assessed environmental characteristics related to PA (walking) with pedometers. In that study, Van Dyck et al. (Van Dyck, Cardon, Deforche, & De Bourdeaudhuij, 2009) found that living in a neighborhood that provides a desirable environment for walking was associated with higher level of PA (i.e. more steps/day), however, the majority of the literature says otherwise (Davison & Lawson, 2006; Holt et al., 2008).

In this context, the aim of this study was to verify if PA behavior (steps/day) was associated with environmental features that may be able to promote PA in a sample of Portuguese adolescents living in the Azorean Archipelago.

Methods

Study design and sampling

Data for the present study derived from a longitudinal school-based study, the Azorean Physical Activity and Health Study II, aimed to evaluate physical activity, physical fitness, overweight/obesity prevalence, health related quality of life and related factors. The study was carried out in six of the nine Azorean Islands, where 95% of the population live (INE, 2003) S. Miguel, Terceira, Faial, Pico, S. Jorge and Graciosa.

All participants in this study were informed about the objectives of the work, and the parent or guardian of each participant provided written informed consent. The study was approved by the Faculty and the Portuguese Foundation for Science and Technology ethics committee and conducted in accordance to the declaration of Helsinki for Human Studies of the World Medical Association.

The population was selected by means of a proportionate stratified random sampling, taking into account the location (island) and the number of students by age and sex in each school. The established number of subjects was 1422, but the sample was oversized in order to prevent loss of information, and because technically it was necessary to do the fieldwork in complete classrooms. Therefore, data were collected for 1525 adolescents. Twenty-five subjects aged < 14.5 or > 18.4; and/or having a health condition that did not allow participating in physical education classes; or had missing information on the variables of interest were excluded, resulting in a total of 1500 participants (892 girls and 698 boys).

Baseline data was collected in the fall of 2008 and one year later (mean follow up length 11.5±2.0 months) 850 subjects were reevaluated. Data for the present study considers only the baseline data and the final sample included in this study was comprised of 948 adolescents (543 girls and 405 boys) aged 15 to 18 years (mean age 16.5±0.9) who had complete data on the variables of interest.

Subjects were evaluated during school physical education classes by physical education teachers specially trained for this data collection (anthropometric measures, physical fitness and questionnaires).

Measures

Anthropometric Measures

Height was measured to the nearest millimeter in bare or stocking feet with the adolescent standing upright against a stadiometer (Holtain Ltd., Crymmych, Pembrokeshire, UK). Weight was measured to the nearest 0.10 kg, with adolescents lightly dressed using a portable electronic weight scale (Tanita Inner Scan BC 532, Tokyo, Japan). Body mass index (BMI) was calculated as weight/height squared (kg/m^2).

Socio-Economic Status

The highest level of parental education (in completed years of education) was considered as a proxy of socio-economic status (SES). Similar procedures had previously been applied in the Portuguese context (J. Mota & Silva, 1999).

Physical Activity

PA was assessed objectively using a sealed pedometer (Kenz LIfecorder Plus, Suzuken Co. Ltd, Nagoya, Japan) worn over seven consecutive days. From the initial 1500 adolescents who participated in this study, 1041 agreed to use pedometers. Participants with fewer than three days (two weekdays and one weekend day) of activity recorded were eliminated from the analysis (74 adolescents) in accordance with previous findings (Ozdoba, Corbin, & Masurier, 2004). Another 19 adolescents whose leisure time PA involved predominantly swimming were also deleted from the analysis. Adolescents were familiarized with the pedometers during a physical education class before the monitoring period. On the first day of monitoring (Monday), adolescents were instructed on pedometer attachment (at the waist), its removal (only during showering, bathing, swimming, or sleeping), and re-attachment each morning before going to school. Pedometer values were taken as the average number of steps/day weighted according to the ratio of weekdays to weekends.

Participants were classified as active or non active based on the 75^{th} percentile values by age and gender.

Environmental Factors

Environmental factors were assessed with the environmental questionnaire developed by Evenson et al. (Evenson et al., 2006) under the dimensions of safety, aesthetics, facilities and transportation. For safety eight questions were asked, four for aesthetics, three for PA facilities and six for transportation. For each question there were five possible response options of disagree a lot, disagree a little, indifferent (neither agree nor disagree), agree a little and agree a lot. An index for each dimension was created based on the responses of the participants. The index is an arithmetic average of the responses of all the questions that composed the each dimension. This questionnaire has been previously validated for Portuguese adolescents (Medeiros, 2009).

Statistic Analysis

Chi-Square test was used to compare gender differences in categorical variables.

Binary logistic regression was used to obtain adjusted odds ratio (OR) and 95% confidence intervals (CI) to analyze the relationship between neighborhood environmental dimensions and PA levels. The Logistic regression analysis was adjusted for gender, BMI, age and socioeconomic status.

Statistical analysis was performed using SPSS 18.0. The level of significance for all analyses was set at 0.05.

Results

The general sample features are shown in Table 1. Boys performed on average more daily steps than girls (p≤ 0.001).

Table 1 - Participant's Characteristics (as means ± SD)

	All (n=948)	**Girls (n=543)**	**Boys (n=405)**	**T-Test (p value)**
Age	16.15 ± 0.971	16.20 ± 0.966	16.09 ± 0.977	0.104
PA (steps/day)	7996.44 ± 3247.61	7653. 27 ± 3014. 71	8456.55 ± 3487. 02	≤ 0.001
BMI	22.94 ± 3.93	22.89 ± 3.72	23.02 ± 4.21	0.620

PA – Physical Activity; BMI – Body mass index; SD –Standard deviation.

Table 2 depicts the percentages of responses to the questionnaire dimensions by PA level. Sixty-three per-cent of the active participants had a positive overall perception of the transportation' dimension (p= 0.020).

Table 2 – Percentages of responses to the environmental questionnaire dimensions by Physical Activity level

Environmental Dimensions		All Low Active	Active	X^2 (p value)
Safety	Disagree	45.9%	41.7%	0.265
	Agree	54.1%	58.3%	
Aesthetics	Disagree	54.4%	52.7%	0.662
	Agree	45.6%	47.3%	
Facilities	Disagree	52.1%	54.4%	0.541
	Agree	47.9%	45.6%	
Transportation	Disagree	45.3%	36.6%	0.020
	Agree	54.7%	63.4%	

X^2 – Chi-Square Test

As seen in Table 3, after adjustments for age, gender, and BMI, binary logistic regression analysis showed that participants with a positive overall perception of the transportation dimension were 44.2% (OR=1.442, p=0.025) more likely to be classified as active, than those with a negative overall perception. No significant results were found for safety, aesthetics, and facilities dimensions.

Table 3 – Adjusted Odds Ratio predicting physical activity from environmental dimensions

		Active		
Environmental Dimensions		**OR***	**95% CI**	**p value**
Safety	Disagree	1		
	Agree	1.067	0.774-1.469	0.693
Aesthetics	Disagree	1		
	Agree	0.979	0.716-1.339	0.896
Facilities	Disagree	1		
	Agree	0.896	0.662-1.214	0.478
Transportation	Disagree	1		
	Agree	1.442	1.048-1.983	0.025

OR – Odds Ratio; 95%CI – 95% Confidence Interval; *Adjusted for gender, body mass index, age and socioeconomic status

Discussion

To our knowledge, this is the first study addressing relationships between perceived environmental attributes and PA among Azorean adolescents.

Our results show that participants with a positive overall perception in the transportation dimension were 44.2% (OR=1.442, p=0.025) more likely to be classified as active, than those with a negative overall perception. No significant results were found for safety, aesthetics, and facilities dimensions.

Those-response issues regarding the number of steps per day appropriate to improve or maintain health is still a matter of debate. While, some authors suggest a minimum of 11,000 steps/day for girls and 13,000 for boys (Tudor-Locke, Hatano, Pangrazi, & Kang, 2008), others suggest between 11,000 and 16,500 for boys and girls (Duncan, Schofield, & Duncan, 2007; Tudor-Locke, Pangrazi, Corbin, & al., 2004; Vincent & Pangrazi, 2002). Our results indicate that on average the number of steps/day of adolescents were lower (7,653 for girls and 8,456 for boys) than recommended.

Previous studies assessing environmental correlates with PA in the Portuguese population are scarce (J. Mota, Almeida, Santos, & Ribeiro, 2005; J. Mota, Santos, Pereira, Teixeira, & Santos, 2011; M. P. Santos, Page, Cooper, Ribeiro, & Mota, 2009; R. Santos, Silva, Santos, Ribeiro, & Mota, 2008). Some authors reported that the existence of recreational facilities was positively associated with PA levels in women (R. Santos et al., 2008) and adolescents (J. Mota et al., 2005; M. P. Santos et al., 2009). Social environment was positively associated with PA levels in women (R. Santos et al., 2008); however, Mota et al. (J. Mota et al., 2005) did not find any association in adolescents. Regarding aesthetics, some authors found that it was positively associated with higher levels of PA (J. Mota et al., 2005; J. Mota et al., 2011; R. Santos et al., 2008).

Our results showed that the transportation dimension was positively associated with PA but the safety dimension was not, and this is interesting and worthy of notice, since these constructs are often related. To support this idea, Veitch et al. (Veitch et al., 2006) it was compiled a questionnaire for parents,

asking them to identify their child's usual play areas. The most common answers were related to the yard of their home, but more than one-third of parents said their child often played outside or in open play spaces, determinants that were also confirmed by Timperio et al. (Timperio, Crawford, Telford, & Salmon, 2004). On the other hand, girls whose parents reported no access to play areas were less likely to walk or cycle in their neighborhood (Timperio et al., 2004). Indeed, safety is an important concern for parents and children (Mullan, 2003). This concern contributes to parental restrictions associated with the independent mobility of their child (Hume et al., 2009; Veitch et al., 2006) and active transport in their own neighborhood (A. Carver, A. Timperio, & D. Crawford, 2008b; Gielen et al., 2004). Carver et al. (2008a) reported that parents' perception of safety was positively associated with adolescent boys' moderate to vigorous physical activity after school. This could be due to adolescents' independence. Veitch et al. (Veitch et al., 2006) reported that parents of older children (9-10 years old) were more likely to allow their child to walk or cycle to friends' houses or to a local place than were parents of young children (6-8 years old). They indicated that having a dog could also provide their child more protection for playing in the street (Mullan, 2003). In some studies, though, no association was found between having a dog and child's protection. (Adkins et al., 2004; J. Mota et al., 2005).

The two second most common parental safety concerns were traffic and "stranger danger" (Veitch et al., 2006). Indeed, several studies have shown that traffic has been negatively associated with PA (Gielen et al., 2004; Health, 2009; Hume et al., 2009; Timperio et al., 2005; Veitch et al., 2006). As for "stranger danger" it was mostly negatively associated with PA (Carver et al., 2008c; Hume et al., 2009; Mullan, 2003; Veitch et al., 2006), though in one case there was not any association between perceived danger from strangers and PA among children (Carver et al., 2008b).

Walking perceptions differ from parent to parent. To support this, Timperio et al. (Timperio et al., 2004) reported that parents link appropriate walking distances to age in children. Parents thought that 1.5±1.1 km was appropriate for children 5-6 years old, while 1.6±1.3 km was appropriate for

children 10-12 years old. In another study by Timperio et al. (Timperio et al., 2006), it was shown that children were more likely to walk or cycle to school if the distance was less than 800m. To reinforce that, other authors found that small trips on foot or bicycle could positively influence PA in children (Davison & Lawson, 2006; Larsen et al., 2009). Regardless of distance, parents reported that children are many times limited to active free play due to crossing roads or because parks do not satisfy children's needs (Veitch et al., 2006).

Studies by Timperio et al. (Timperio et al., 2006) and de Vries et al. (de Vries, Hopman-Rock, Bakker, Hirasing, & van Mechelen, 2010b) revealed that approximately 50% and 40% of children were walking and biking, respectively, to school, although Panter et al. (Panter et al., 2010) reported that only 40% and 9% of children walked and cycled to school respectively, showing clearly that active transport is diminishing. Regarding adolescents, two studies (Larsen et al., 2009; Timperio et al., 2006) came up with the same percentage (62%) of walking and cycling to school. Still, we assessed one longitudinal study conducted by Buliung et al. (Buliung, Mitra, & Faulkner, 2009) that showed adolescents of 14-15 years were less likely to walk (40-50%) or cycle (1-3%) to school.

Not many children (Pont, Ziviani, Wadley, Bennett, & Abbott, 2009) or adolescents (Dollman & Lewis, 2007) travel to locations other than school, such as parks/playgrounds, shops, or friends' houses in their neighborhood. Little is known about access to public transport, but what some authors did find is that public transport is positively associated with PA in children (Hume et al., 2009). To help understand this idea, de Vries et al. (de Vries et al., 2010b) found that 93% of children walked or cycled to public transport at least once a week. Other results show that a few walked or cycled to public transport (Timperio et al., 2004).

The fact that safety was not associated with PA in this sample may be due to the fact that the majority of the participants in this study (regardless of their PA level) did not consider safety a problem (data not shown), as it was previously reported in Azorean adults (R. Santos et al., 2008).

Study Limitations and Strengths

Due to the cross-sectional nature of this study, we should recognize that the positive associations found between PA and environmental features may not reflect a long-time exposure to this kind of environment in this sample. The strengths of this study include the objective measurement of PA by pedometer in a large sample of Azorean adolescents.

Conclusions

In Azorean adolescents, a positive overall perception of the transportation dimension was positively associated with PA. No significant results were found for safety, facilities, and aesthetics' dimensions.

Future health promotion strategies aimed to increase PA in this population should consider the environmental features that are associated with PA levels.

Acknowledgments

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Competing Interest: There are any financial and non-financial competing interests.

3. Limitations and Strengths

3. Limitations and Strengths

This master thesis is not without limitations. First, in the review, the keywords used to retrieve studies from existing literature may have not been accurate enough. The main outcome was overall PA, not enabling to determine the specific environmental correlates of specific physical activities. Some studies did not use objective measures for PA. Due to the cross-sectional nature of the second paper, it should be recognized that the positive associations found between PA and environmental features may not reflect a long-time exposure to this kind of environment in this sample.

Although the few databases searched we managed to find a considerable amount of studies fulfilling the selection criteria. In the original research article we included the objective measurement of PA by pedometer in a large sample of Azorean adolescents.

4. Conclusions

4. Conclusions

The environment can give children and adolescents the possibility to be physically active, nevertheless there will always be external influences that can contribute to children's and adolescents' PA such as parental or peer influences. Youth are in many ways affected by their parents' and their own environmental perceptions of safety. Thus, with this in mind, finding which environmental features contributes the most for PA levels in youth becomes relevant on a major health level.

Regarding children, we found that the presence of sidewalks and bike lanes were always positively associated with PA. The existence of nearby facilities (e.g. shops, friends' houses, basketball or tennis courts) and parks/playgrounds was compelling in most of studies on its positive association with PA. Although safety and traffic were the two most studied environmental features, their association with PA remains inconclusive, as well as the weather.

In Azorean adolescents, a positive overall perception of the transportation dimension was positively associated with PA. No significant results were found for safety, facilities, and aesthetics' dimensions. Therefore, future health promotion strategies aimed to increase PA in this population should consider the environmental features that are associated with PA levels.

Beginning to understand which environmental features contribute more to PA in youth can lead to increased levels of PA.

5. References

5. References

Adkins, S., Sherwood, N. E., Story, M., & Davis, M. (2004). Physical activity among African-American girls: the role of parents and the home environment. *Obes Res, 12 Suppl*, 38S-45S.

Alton, D., Adab, P., Roberts, L., & Barrett, T. (2007). Relationship between walking levels and perceptions of the local neighbourhood environment. *Arch Dis Child, 92*(1), 29-33.

Andersen, L. B., Harro, M., Sardinha, L. B., Froberg, K., Ekelund, U., Brage, S., & Anderssen, S. A. (2006). Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). *Lancet, 368*(9532), 299-304.

Ball, K., Timperio, A., & Crawford, D. (2006). Understanding environmental influences on nutrition and physical activity behaviors: where should we look and what could we count? *International Journal of Behavioral Nutrition and Physical Activity, 3*, 33.

Biddle, S. J., Gorely, T., & Stensel, D. J. (2004). Health-enhancing physical activity and sedentary behaviour in children and adolescents. *J Sports Sci, 22*(8), 679-701.

Blair, S. N., & Brodney, S. (1999). Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. *Med Sci Sports Exerc, 31*(11 Suppl), S646-662.

Boarnet, M. G., Anderson, C. L., Day, K., McMillan, T., & Alfonzo, M. (2005). Evaluation of the California Safe Routes to School legislation: urban form changes and children's active transportation to school. *Am J Prev Med, 28*(2 Suppl 2), 134-140.

Borrestad, L. A., Andersen, L. B., & Bere, E. (2011). Seasonal and socio-demographic determinants of school commuting. *Prev Med, 52*(2), 133-135.

Bringolf-Isler, B., Grize, L., Mader, U., Ruch, N., Sennhauser, F. H., & Braun-Fahrlander, C. (2008). Personal and environmental factors associated with active commuting to school in Switzerland. *Prev Med, 46*(1), 67-73.

Brodersen, N. H., Steptoe, A., Williamson, S., & Wardle, J. (2005). Sociodemographic, deveopmental, environmental, and psychological correlates of physical activity and sedentary behavior at age 11 to 12. *Amals of Behavioral Medicine, 29*(1), 2-11.

Buliung, R. N., Mitra, R., & Faulkner, G. (2009). Active school transportation in the Greater Toronto Area, Canada: an exploration of trends in space and time (1986-2006). *Prev Med, 48*(6), 507-512.

Carson, V., Kuhle, S., Spence, J. C., & Veugelers, P. J. (2010). Parents' perception of neighbourhood environment as a determinant of screen time, physical activity and active transport. *Can J Public Health, 101*(2), 124-127.

Carver, A., Timperio, A., & Crawford, D. (2008a). Perceptions of neighborhood safety and physical activity among youth: the CLAN study. *J Phys Act Health, 5*(3), 430-444.

Carver, A., Timperio, A., & Crawford, D. (2008b). Playing it safe: the influence of neighbourhood safety on children's physical activity. A review. *Health Place, 14*(2), 217-227.

Carver, A., Timperio, A., Hesketh, K., & Crawford, D. (2009). Are safety-related features of the road environment associated with smaller declines in physical activity among youth? *Journal of Urban Health, 87*(1), 29-43.

Carver, A., Timperio, A., Hesketh, K., & Crawford, D. (2010). Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? *Soc Sci Med, 70*(11), 1799-1805.

Carver, A., Timperio, A. F., & Crawford, D. A. (2008c). Neighborhood road environments and physical activity among youth: the CLAN study. *J Urban Health, 85*(4), 532-544.

Cohen, D., Golinelli, D., Williamson, S., Sehgal, A., Marsh, T., & McKenzie, T. L. (2009). Effect of park improvements on park use and physical activity policy and programming implications. *American Journal of Preventive Medicine, 37*(6).

Crawford, D., Cleland, V., Timperio, A., Salmon, J., Andrianopoulos, N., Roberts, R., . . . Ball, K. (2010). The longitudinal influence of home and neighbourhood environments on children's body mass index and physical activity over 5 years: the CLAN study. *Int J Obes (Lond), 34*(7), 1177-1187.

D'Haese, S., De Meester, F., De Bourdeaudhuij, I., Deforche, B., & Cardon, G. (2011). Criterion distances and environmental correlates of active commuting to school in children. *Int J Behav Nutr Phys Act, 8*, 88.

Davison, K. K., & Lawson, C. T. (2006). Do attributes in the physical environment influence children's physical activity? A review of the literature. *Int J Behav Nutr Phys Act, 3*, 19.

de Vries, S. I., Bakker, I., van Mechelen, W., & Hopman-Rock, M. (2007). Determinants of activity-friendly neighborhoods for children: results from the SPACE study. *Am J Health Promot, 21*(4 Suppl), 312-316.

de Vries, S. I., Hopman-Rock, M., Bakker, I., Hirasing, R. A., & van Mechelen, W. (2010a). Built environmental correlates of walking and cycling in Dutch urban children: results from the SPACE study. *Int J Environ Res Public Health, 7*(5), 2309-2324.

de Vries, S. I., Hopman-Rock, M., Bakker, I., Hirasing, R. A., & van Mechelen, W. (2010b). Built Environmental Correlates of Walking and Cycling in Dutch Urban Children: Results from the SPACE study. *International Journal of Environmental Research and Public Health, 7*, 2309-2324.

DeLany, J. P., Bray, G. A., Harsha, D. W., & Volaufova, J. (2002). Energy expenditure in preadolescent African American and white boys and girls: the Baton Rouge Children's Study. *Am J Clin Nutr, 75*(4), 705-713.

Dollman, J., & Lewis, N. R. (2007). Active transport to school as part of a broader habit of walking and cycling among South Australian youth. *Pediatr Exerc Sci, 19*(4), 436-443.

Duncan, J. S., Schofield, G., & Duncan, E. K. (2007). Step count recommendations for children based on body fat. *Prev Med, 44*(1), 42-44.

Evenson, K. R., Birnbaum, A. S., Bedimo-Rung, A. L., Sallis, J. F., Voorhees, C. C., Ring, K., & Elder, J. P. (2006). Girls' perception of physical environmental factors and transportation: reliability and association with physical activity and active transport to school. *Int J Behav Nutr Phys Act, 3*, 28.

Farley, T. A., Meriwether, R. A., Baker, E. T., Watkins, L. T., Johnson, C. C., & Webber, L. S. (2007). Safe play spaces to promote physical activity in inner-city children: results from a pilot study of an environmental intervention. *American Journal of Public Health, 97*(9), 1625-1631.

Fein, A. J., Plotnikoff, R. C., Wild, C., & Spence, J. C. (2004). Perceived environment and physical activity in youth. *International Journal of Behavioral Medicine, 11*(3), 135-142.

Freedson, P. S., & Miller, K. (2000). Objective monitoring of physical activity using motion sensors and heart rate. *Res Q Exerc Sport, 71*(2 Suppl), S21-29.

Gielen, A. C., Defrancesco, S., Bishai, D., Mahoney, P., Ho, S., & Guyer, B. (2004). Child pedestrians: the role of parental beliefs and practices in promoting safe walking in urban neighborhoods. *J Urban Health, 81*(4), 545-555.

Giles-Corti, B., Kelty, S. F., Zubrick, S. R., & Villanueva, K. P. (2009). Encouraging walking for transport and physical activity in children and adolescents: how important is the built environment? *Sports Med, 39*(12), 995-1009.

Giles-Corti, B., Wood, G., Pikora, T., Learnihan, V., Bulsara, M., Van Niel, K., . . . Villanueva, K. (2011). School site and the potential to walk to school: the impact of street

connectivity and traffic exposure in school neighborhoods. *Health Place, 17*(2), 545-550.

Guthold, R., Ono, T., Strong, K. L., Chatterji, S., & Morabia, A. (2008). Worldwide variability in physical inactivity a 51-country survey. *Am J Prev Med, 34*(6), 486-494.

Harrison, F., Jones, A. P., Bentham, G., van Sluijs, E. M., Cassidy, A., & Griffin, S. J. (2011). The impact of rainfall and school break time policies on physical activity in 9-10 year old British children: a repeated measures study. *Int J Behav Nutr Phys Act, 8*, 47.

Health, C. o. E. (2009). The built environment: designing communities to promote physical activity in children. *Pediatrics, 123*(6), 1590-1599.

Holt, N. L., Spence, J. C., Sehn, Z. L., & Cutumisu, N. (2008). Neighborhood and developmental differences in children's perceptions of opportunities for play and physical activity. *Health Place, 14*(1), 2-14.

Hume, C., Salmon, J., & Ball, K. (2005). Children's perceptions of their home and neighborhood environments, and their association with objectively measured physical activity: a qualitative and quantitative study. *Health Education Research, 20*(1), 1-13.

Hume, C., Salmon, J., & Ball, K. (2007). Associations of children's perceived neighborhood environments with walking and physical activity. *Am J Health Promot, 21*(3), 201-207.

Hume, C., Timperio, A., Salmon, J., Carver, A., Giles-Corti, B., & Crawford, D. (2009). Walking and cycling to school: predictors of increases among children and adolescents. *Am J Prev Med, 36*(3), 195-200.

INE. (2003). Instituto Nacional de Estatística. Estimativas da População Residente, segundo Grandes Grupos Etários e Sexo, em 31/12/2003. [National Institute of Statistics. Estimation of the Resident Population, According to Age and Gender, in 31/12/2003].

Jones, A. P., van Sluijs, E. M., Ness, A. R., Haynes, R., & Riddoch, C. J. (2010). Physical activity in children: does how we define neighbourhood matter? *Health Place, 16*(2), 236-241.

Karsten, L. (2005). It all used to be better? Different generations on continuity and change in urban children's daily use as space. *Children's Geographies, 3*, 275-290.

King, A. C., Stokols, D., Talen, E., Brassington, G. S., & Killingsworth, R. (2002). Theoretical approaches to the promotion of physical activity: forging a transdisciplinary paradigm. *Am J Prev Med, 23*(2 Suppl), 15-25.

Larsen, K., Gilliland, J., Hess, P., Tucker, P., Irwin, J., & He, M. (2009). The influence of the physical environment and sociodemographic characteristics on children's mode of travel to and from school. *Am J Public Health, 99*(3), 520-526.

Maas, J., Verheij, R. A., Spreeuwenberg, P., & Groenewegen, P. P. (2008). Physical activity as a possible mechanism behind the relationship between green space and health: a multilevel analysis. *BMC Public Health, 8*.

McDonald, N. C. (2007). Active transportation to school: trends among U.S. schoolchildren, 1969-2001. *Am J Prev Med, 32*(6), 509-516.

Medeiros, L. C. O. (2009). *Associação do envolvimento físico com níveis de obesidade, aptidão física, atividades sedentárias e participação desportiva: um estudo em alunos do 2º e 3º ciclos, e Ensino Secundário de um concelho rural da RAM. [Environmental associations with obesity, physical fitness, sedentary activities and sport participation: a study of middle and high school students form RAM's rural county.].* Universidade da Madeira - Dissertação de Mestrado [Madeira University - Master Thesis].

Moreau, K. L., Degarmo, R., Langley, J., McMahon, C., Howley, E. T., Bassett, D. R., Jr., & Thompson, D. L. (2001). Increasing daily walking lowers blood pressure in postmenopausal women. *Med Sci Sports Exerc, 33*(11), 1825-1831.

Mota, J., Almeida, M., Santos, P., & Ribeiro, J. C. (2005). Perceived Neighborhood Environments and physical activity in adolescents. *Prev Med, 41*(5-6), 834-836.

Mota, J., Santos, R., Pereira, M., Teixeira, L., & Santos, M. P. (2011). Perceived neighbourhood environmental characteristics and physical activity according to socioeconomic status in adolescent girls. *Ann Hum Biol, 38*(1), 1-6.

Mota, J., & Silva, G. (1999). Adolescent's Physical Activity: Association with Socio-Economic Status and Parental Participation among a Portuguese sample. *Sport, Education and Society, 4*, 193-199.

Mullan, E. (2003). Do you think that your local area is a good place for young people to grow up? The effects of traffic and car parking on young people's views. *Health Place, 9*(4), 351-360.

Ozdoba, R., Corbin, C., & Masurier, G. (2004). Does reactivity exist in children when measuring activity levels with unsealed pedometers? *Pediatric Exercise Science, 16*, 158-166.

Panter, J. R., Jones, A. P., Van Sluijs, E. M., & Griffin, S. J. (2010). Neighborhood, route, and school environments and children's active commuting. *Am J Prev Med, 38*(3), 268-278.

Pont, K., Ziviani, J., Wadley, D., Bennett, S., & Abbott, R. (2009). Environmental correlates of children's active transportation: a systematic literature review. *Health Place, 15*(3), 827-840.

Retting, R. A., Ferguson, S. A., & McCartt, A. T. (2003). A review of evidence-based traffic engineering measures designed to reduce pedestrian-motor vehicle crashes. *Am J Public Health, 93*(9), 1456-1463.

Rodriguez, A., & Vogt, C. A. (2009). Demographic, environmental, access, and attitude factors that influence walking to school by elementary school-aged children. *J Sch Health, 79*(6), 255-261.

Roemmich, J. N., Epstein, L. H., Raja, S., & Yin, L. (2007). The neighborhood and home environments: disparate relationships with physical activity and sedentary behaviors in youth. *Ann Behav Med, 33*(1), 29-38.

Rosenberg, D., Ding, D., Sallis, J. F., Kerr, J., Norman, G. J., Durant, N., . . . Saelens, B. E. (2009). Neighborhood Environment Walkability Scale for Youth (NEWS-Y): reliability and relationship with physical activity. *Prev Med, 49*(2-3), 213-218.

Sallis, J. F., & Glanz, K. (2006). The role of built environments in physical activity, eating, and obesity in childhood. *Future Child, 16*(1), 89-108.

Santos, M. P., Page, A. S., Cooper, A. R., Ribeiro, J. C., & Mota, J. (2009). Perceptions of the built environment in relation to physical activity in Portuguese adolescents. *Health & Place, 15*(2), 548-552.

Santos, R., Silva, P., Santos, P., Ribeiro, J. C., & Mota, J. (2008). Physical activity and perceived environmental attributes in a sample of Portuguese adults: results from the Azorean Physical Activity and Health study. *Prev Med, 47*(1), 83-88.

Scott, M. M., Evenson, K. R., Cohen, D. A., & Cox, C. E. (2007). Comparing perceived and objectively measured access to recreational facilities as predictors of physical activity in adolescent girls. *J Urban Health, 84*(3), 346-359.

Sirard, J. R., Ainsworth, B. E., McIver, K. L., & Pate, R. R. (2005). Prevalence of active commuting at urban and suburban elementary schools in Columbia, SC. *Am J Public Health, 95*(2), 236-237.

Smith, B. J., Grunseit, A., Hardy, L. L., King, L., Wolfenden, L., & Milat, A. (2010). Parental influences on child physical activity and screen viewing time: a population based study. *BMC Public Health, 10*, 593.

Spengler, J. O., Floyd, M. F., Maddock, J. E., Gobster, P. H., Suau, L. J., & Norman, G. J. (2011). Correlates of park-based physical activity among children in diverse communities: results from an observational study in two cities. *Am J Health Promot, 25*(5), e1-9.

Tandy, C. (1999). Children's diminishing play space: a study of inter-generational change in children's use of their neighborhood. *Aust Geogr Stud, 37*, 154-164.

Timperio, A., Ball, K., Salmon, J., Roberts, R., Giles-Corti, B., Simmons, D., . . . Crawford, D. (2006). Personal, family, social, and environmental correlates of active commuting to school. *Am J Prev Med, 30*(1), 45-51.

Timperio, A., Crawford, D., Telford, A., & Salmon, J. (2004). Perceptions about the local neighborhood and walking and cycling among children. *Prev Med, 38*(1), 39-47.

Timperio, A., Giles-Corti, B., Crawford, D., Andrianopoulos, N., Ball, K., Salmon, J., & Hume, C. (2008). Features of public open spaces and physical activity among children: findings from the CLAN study. *Prev Med, 47*(5), 514-518.

Timperio, A., Salmon, J., Telford, A., & Crawford, D. (2005). Perceptions of local neighbourhood environments and their relationship to childhood overweight and obesity. *Int J Obes (Lond), 29*(2), 170-175.

Tranter, P., & Doyle, J. (1996). Reclaiming the residential street as play space. *Int Play J, 4*, 91-97.

TRB, & IMNA. (2005). *Does the built environment influence Physical Activity? Examining the Evidence.* Washington, DC.: Transportation Research Board and Institute of Medicine of the National Academies.

Tudor-Locke, C., Hatano, Y., Pangrazi, R., & Kang, M. (2008). Revisiting "How many steps/day are enough?". *Med Sci Sports Exerc*, S537-S543.

Tudor-Locke, C., Pangrazi, R. P., Corbin, C. B., & al., e. (2004). BMI-referenced standards for recommended pedometer-determined steps/day in children. *Prev Med, 38*(6), 857-864.

USDHHS. (2008). *Physical Activity Guidelines for Americans*.

Van Der Horst, K., Paw, M. J., Twisk, J. W., & Van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc, 39*(8), 1241-1250.

Van Dyck, D., Cardon, G., Deforche, B., & De Bourdeaudhuij, I. (2009). Lower neighbourhood walkability and longer distance to school are related to physical activity in Belgian adolescents. *Prev Med, 48*(6), 516-518.

Veitch, J., Bagley, S., Ball, K., & Salmon, J. (2006). Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health Place, 12*(4), 383-393.

Veitch, J., Salmon, J., & Ball, K. (2008). Children's active free play in local neighborhoods: a behavioral mapping study. *Health Educ Res, 23*(5), 870-879.

Veitch, J., Salmon, J., & Ball, K. (2010). Individual, social and physical environmental correlates of children's active free-play: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity, 7*, 11.

Vincent, S. D., & Pangrazi, R. (2002). An examination of the activity patterns of elementary school children. *Pediatr Exerc Sci, 14*, 432-441.

WHO. (2004). *Global Strategy on Diet, Physical Activity and Health*. (3). Retrieved from http://www.who.int/gb/ebwha/pdf_files/WHA57/A57_R17-en.pdf.

WHO. (2010). World Health Organization.Global recommendations on physical activity for health. Switzerland.

Zhu, X., Arch, B., & Lee, C. (2008). Personal, social, and environmental correlates of walking to school behaviors: case study in Austin, Texas. *ScientificWorldJournal, 8*, 859-872.