Impact of walkability with regard to physical activity in the prevention of diabetes

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Abstract

Walkability, a component of urban design intended to facilitate pedestrian traffic, depends on parameters associated with the connectivity of routes, population density and availability of destinations in the neighbourhood. The aim is to achieve levels of physical activity related to the prevention of risk factors associated with diseases, such as diabetes and the improvement of glycaemia control. It is important to consider that the effects of walkability depend on its relation with other variables present in the neighbourhood, *e.g.*, environmental and socioeconomic factors. Considering this, improving walkability levels could be an effective strategy to reduce disease, the prevalence of diabetes in particular, in the population and thus reduce public spending. To investigate these relationships, PUBMED and ScienceDirect databases were searched using the following key words: Diabetes, Walkability and Physical activity.

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Introduction

Walkability, a component of built environment associated with the degree a neighbourhood, supports walking; it thus depends on variables related to connectivity, population density and ability to reach destinations (Glazier *et al*., 2008). Street connectivity corresponds to the number of intersections present in a neighbourhood; it facilitates pedestrian traffic, provides options for travelling between local origins and destinations and plays a role in slowing motorised traffic as a result of multiple stopping sites (Handy *et al*., 2003). Land use mix refers to the variety of possible destinations in a neighbourhood connected with office, retail, industrial, service, entertainment, education and public sector facilities (Duncan *et al*., 2010), while walkable destinations is an associated concept that refers to the number of destinations present in a neighbourhood (Carr *et al*., 2011). Residential (or population) density is defined as the number of residences (or people) per km^2 in a neighbourhood (Brownson *et al*., 2009; Johnson-Lawrence *et al*., 2015). The presence of a high number of people requires a high demand for accessible routes and stores. The composition of a walkability index usually adapts these factors at the sites where applied (Glazier *et al*., 2008).

There are different ways to measuring walkability. It is primarily approached by determining the perceived walkability using surveys (Notthoff and Carstensen, 2015). Objective walkability is usually investigated using a geographic information system (GIS); it considers variables of connectivity, density and ability of reaching destinations (Mayne *et al*., 2013; Frank *et al*., 2010) Walkability indices have been employed for investigation of associations between urban design and different outcomes; They can be used to identify priority areas for transportation enhancements and it can be applied to monitor changes in urban settings over time (Frank *et al*., 2010). In developed countries, this kind of information has been used to develop public policies of transportation and urbanity. In Australia, under the Sydney Metropolitan Strategy, a walkability index has been important in identifying the need for urban design that encourages pedestrian and cyclist traffic (Mayne *et al*., 2013). Walk Score® is another tool used to evaluate walkability based on distance to various amenities, which has shown a good correlation with GIS-measured walkability indices (Duncan *et al*., 2011). Although based on accessible and free data, it does not consider aspects such as population density or connectivity, while latent profile analysis (LPA) is an approach aimed at the study of walkability parameters in combination with other built environment factors that allows estimation of co-occurring impacts like physical activity (Kurka *et al*., 2015).

Type 2 diabetes mellitus (T2DM) represents a major public health problem. It currently represents an important cause of mortality and disability, as it predisposes the development of neuropathies, cardiovascular and kidney diseases. Projections show that the prevalence of these diseases will increase in the following decades due to the aging of the population, but also due to increasingly sedentary lifestyles and the consequent rise of obesity (Wild *et al*., 2004; Lipscombe and Hux, 2007). Frequent physical activity (PA) has been shown to prevent the development of diabetes (Lambert and Bull, 2014), while it improves control of glycaemia and quality of life in diabetic patients (Colak *et al*., 2016; Rice *et al*., 2016). Built environment corresponds to the totality of places designed and built by humans (Sallis *et al*., 2012). Different studies have identified walkability as a PA promoter in a chosen neighbourhood, and the role of neighbourhood design has been given much thought with respect to health in recent years (Frank and Engelke, 2001; Sallis *et al*., 2012). Built environment could play an important role in the prevention of non-communicable diseases, such as diabetes, mainly by promoting physical activity. Recent studies have suggested that transitability may be a protective factor against the development of diabetes (Muller-Riemenschneider *et al*., 2013; Glazier *et al*., 2014). Indeed, a correlation has been established between the PA such as walking/running and incidence of this disease (Yates *et al*., 2014). For this reason, planning of built environment encouraging PA would contribute to a better control of glycaemia.

In this article, we review the protective role of walkability with respect to diabetes and its relation with prevalence and incidence of this disease, examining factors that favour the development of regular physical activities.

Materials and Methods

To investigate which associated factors primarily influence the development of diabetes, PUBMED and ScienceDirect databases were searched using the following key words: Diabetes, Walkability and Physical activity. These search terms delivered a total of 38 articles using both databases. *Walkability* appeared independently 7 times in the title and 5 times in the abstract; the combination *Walkability* and *Diabetes* appeared 4 times in the title and 9 times in the abstract; *Walkability* and *Physical activity* appeared once in the title and 5 times in the abstract; while the three words together appeared twice in the title and 14 times in the abstract. Thirty-three publications were original articles with other types of articles in minority: one systematic review, one systematic review with meta-analysis, two reviews and one editorial letter.

Results and Discussion

Prevalence of diabetes and walkability

Recent cross-sectional studies show a correlation between walkability and prevalence of diabetes (Muller-Riemenschneider *et al*., 2013; Glazier *et al*., 2014). This is related to effects of walkability on diabetes risk factors. For example, the high body mass index (BMI) prevalence decreases with walkability (Sallis *et al*., 2009; Duncan *et al*., 2014), while moving to a highly walkable neighbourhood reduces BMI (Wasfi *et al*., 2016). Age is another risk factor where walkability counteracts the development of diabetes as it is associated with increased PA (King *et al*., 2011; Van Holle *et al*., 2016). The effects of walkability tend to be more effective in men. This correlation is generally significant when evaluated in the immediate radius but loses significance when the range of analysis is extended (Muller-Riemenschneider *et al*., 2013). It is likely that the effects of walkability on diabetes prevalence is linked not only to the fact that people walk more, but also to factors such as increase of bicycle use and public transport instead of owned-car use (Glazier *et al*., 2014). The main disadvantage of these studies is that they are cross-sectional, so a correlation between diabetes and walkability is only suggested and the results cannot be used as evidence of a causal relation (Sedgwick, 2014).

Effects of walkability on diabetes incidence

The perception of how friendly a neighbourhood is for the development of PA is also important. Based on a 5-year survey, Auchincloss *et al*. (2009) showed the importance of the suitability of the neighbourhood for PA in the development of diabetes, *i.e*. the stronger the perception of the walkability of a neighbourhood, the lower the incidence of diabetes. This has been partly corroborated by Canadian study, carried out in Ontario, Canada between the years 2001-2012 (Creatore *et al*., 2016). However, the initial prevalence of T2DM in this study was decreases only in the highest quintile of the degree of walkability, while the diabetes incidence did not vary significantly in the lower quintiles. Sundquist and collaegues (2015) initially found that the incidence of diabetes decreased with walkability, but that this correlation lost significance when adjusted by socio-demographic features. They used prescription of drug treatment for diabetes as proxy, so cases of diabetes not treated pharmacologically were excluded (Sundquist *et al*., 2015). In contrast, a study investigating cardio-metabolic risk factors based on laboratory parameters using HbA1c and fasting glucose for the diagnosis pre-diabetes or diabetes showed that the risk of developing these disorders was lower in areas with greater walkability qualities (Paquet *et al*., 2014). In accordance, Booth and co-workers (Booth *et al*., 2013) found that the diabetes incidence increases in environments less favourable for walking, a situation particularly pronounced in immigrants, a group prone to developing diabetes due to acculturation, *i.e*. change in lifestyle when adapting to another culture (Misra and Ganda, 2007).

Effects of walkability in diabetic patients

PA has favourable effects in T2DM patients (Yates *et al*., 2014). There are different factors that determine the performance of PA in this connection. Among these are environmental, sociodemographic, psychosocial factors, *etc*. (Van Holle *et al*., 2015; Marques *et al*., 2016; Graziose *et al*., 2016). Walkability may be an important environmental factor in the promotion of PA among people with T2DM (De Greef *et al*., 2011). Diabetics living in highly walkable areas do more daily steps than others, which may have clinical significance when adjusted for variables such as age, BMI and gender, but loses clinical importance when adjusting for car access (Colley *et al*., 2011). On the other hand, it has been noted that overall walkability is related to expert recommendations that diabetics should aim at walking for ≥150 minutes per week (Hosler *et al*., 2014). In fact, a study by Hajna and colleagues (2016) has shown that T2DM patients living in areas with a high-walkability index do more steps per day compared to diabetics in area characterised by a low-walkability index.

Prevention of diabetes: Walkability and physical activity

There is a negative correlation between objectively measured walkability and sedentary behaviour, *e.g.*, watching TV (Sugiyama *et al*., 2007; Kozo *et al*., 2012) or driving a car (Kozo *et al*., 2012; Koohsari *et al*., 2014). Walkability promotes the development of PA and is thus related to increases in moderate to vigorous physical activity (MVPA) and walking. The latter is a PA can be divided into utilitarian walking and leisure-time walking; together they make up the total walking time (Hajna *et al*., 2015). As seen in Table 1, walkability is associated with increased utilitarian walking, while the correlation with leisure-time walking is weak.

Table 1 summarises the findings of different studies linking PA with walkability indices. In most of the above-mentioned studies, GIS-based surveys contribute significantly. These systems comprise collection, management and interpretation of complex geospatial information, where geo-referencing allows all study subjects to be positioned in the territory under examination, a situation which generates radii along which walkability information for each subject can be obtained and calculated. For example, in the study by Todd *et al*. (2016), the ArcGIS 10.0 software (ESRI, Redlands, CA, USA) was used to determine the walkability parameters of the study area, such as net residential density, intersection density, land use mix (diversity and accessibility of nearby destinations) and retail floor area ratio (which indicates the likely retail development) for a 1-km radius for each of the participants in the study. Participants can be classified into different groups according to the level of walkability: quartiles, quintiles, deciles, *etc*. In this way, it is possible to relate walkability to the level of PA developed in each group and to measure the contribution of walkability in the achievement of PA goals that lead to overall health benefits in the general population, in particular in groups of individuals or in people with particular ailments. For example, the influence of walkability achieving ≥150 minutes per week of walking in diabetics may be determined; or 75 min per week of intense PA in older adults. In this way, the GIS approach contributes to defining the characteristics of the routes and distances to be realised to obtain health benefits for different interest groups.

Studies comparing physical activity according to walkability use two different strategies to measure it. Surveys are an economical way to collect information from a large number of individuals but have the disadvantage of being subjective, while accelerometers and pedometers allow the registration of objective PA information. However, they are relatively expensive limiting the number of participants than can be studied. Differences between these strategies exist with respect to the value of PA reported, something which is frequently overestimated by surveys (Dyrstad *et al*., 2014; Lipert and Jegier, 2016; Liu *et al*., 2016b). However, usually there is a good correlation in trends of PA and health when comparing these methods (Meriwether *et al*., 2006; De Cocker *et al*., 2009; Schuna *et al*., 2013). Table 1 provides an overview of how general walkability is related to other forms of PA, measured subjectively or objectively.

As can be seen from Table 1, walkability can determine significant differences in PA performance, and these differences can promote concrete improvements in parameters associated with diabetes. People making ≥30 min per day of MVPA had lower BMI and lower levels of glycosylated haemoglobin (HbA1c), a laboratory parameters for control of diabetes. (Hamer *et al*., 2012). Interventions aimed at PA increase showed that a change from 13 min per day to 18 min of moderate PA is associated with a HbA1c decrease from 8.9% to 7.7% and a BMI decrease from 37.11 to 36.58 kg/m^2 (Allen *et al*., 2008). Another study (Swartz *et al*., 2007) compared differences in steps per day between older volunteers with recommended levels of HbA1c and those without. Voluntaries with controlled HbA1c levels (mean of 5.8%) were stronger walkers than a group with uncontrolled HbA1c (mean of 8.7%), the former group making 1,343 more steps per day on average than the latter.

Metabolic Equivalent of Task (MET) is a unit of energetic expenditure that corresponds to the amount of energy spent in an activity relative to the energy spent at rest (Bushman, 2012). The MET values for diverse activities of different intensity have been defined by Ainsworth *et al*. (2011). Expressing this expenditure as MET hours per week may be useful for setting goals for the physical activity performed for a given purpose (Matthews *et al*., 2007; Gielen *et al*., 2015). It can be useful to express the benefit of various degrees of PA as MET values, *e.g*., diabetics increasing their energy expenditure with at least 11 MET hours per week show significant reductions in several parameters, such as HbA1c, blood pressure, total cholesterol and triglycerides (Di Loreto *et al*., 2005). Another study describes that HbA1c decreases with 0.1% for every 30 MET hour increase per week (Barakat *et al*., 2013). MET expenditure has also an effect on mortality due to diabetes: diabetics classified into four groups according their daily MET expenditure (≤7.5; 7.5-12.6; 12.6-25.2 and ≥25.2 MET hours per week) and followed for 9 years lowered the mortality with 39.4%, 63.8% and 90.6%, respectively, in the three highest MET daily expenditure groups compared to lowest (Williams, 2013). Whenever possible, we calculated the difference in MET hours per week between the neighbourhoods with the greatest transitability and those with the lowest (Table 1). In others words, the simple fact of living in a high-walkability neighbourhood means an advantage with regard to health and protection against the development of diabetes.

Influence of other factors on walkability in the prevention of diabetes

We have reviewed the role of walkability, a component of the built environment, as a protective element in the development of diabetes. However, in practice, its benefits depend also on the interaction with other factors present in the neighbourhood (Figure 1). The effect of how the environment is perceived has been studied from various perspectives and how this influences walking: aesthetics (Sugiyama *et al*., 2014), rout quality (Hallal *et al*., 2010; Sugiyama and Thompson, 2008) and the degree of access to green areas and recreational spaces (Sugiyama and Thompson, 2008; Hallal *et al*., 2010; Stathi *et al*., 2012; Sugiyama *et al*., 2014). Access to parks has been linked to increased physical activity (Roemmich *et al*., 2006) and decreased BMI (Mena *et al*., 2015). In addition, neighbourhood access to healthy foods (presence of supermarkets and fruit-vegetable stores) as well as the presence of recreational facilities (dance, bowling, water activities, team sports, *etc*.) are independently associated with a lower incidence of diabetes (Christine *et al*., 2015).

Social support from family and friends (Rech *et al*., 2014), in addition to having activity partners (Stathi *et al*., 2012), encourage PA. Conversely, but not surprising, the perceived criminal insecurity of the neighbourhood (Evenson *et al*., 2012; Sugiyama *et al*., 2014) as well as high homicide rates (Lovasi *et al*., 2013; Gomes *et al*., 2016) are related to a decreased PA. The socioeconomic status largely determines these variables; high-income neighbourhoods have more favourable patterns with respect to aesthetics,

Table 1. Physical activity related to walkability.

Type of physical activity	No of subjects studied	Population sector of special interest (years)	Area, region, country	Measure of walkability	Tool or approach used	Parameter measured	Results in the low-walkability group	Results in the high-walkability group	ΔMET h/week*	References
Overall walking	70	20 to 64	Olomouc, Czech Republic	GIS walkability index	Pedometer	Steps per day	9,230 steps/day	11,318 steps/day		Dygryn *et al.* (2010)
	120	20 to 65	Sint-Niklaas, Belgium	GIS walkability index	Pedometer	Steps per day	8,096 steps/day	9,318 steps/day		Van Dyck *et al.* (2009)
	16,944	18 to 64	Queensland, Australia	Walk score™	Survey reported 24 hours	% walk (any trip)	6.2%	22.8%		Cole *et al.* (2015)
						% walk ≥30 min per trip	2.8%	9.4%		
						Mean trip duration	2.5 min	7.5 min		
Utilitarian walking	151,318	> 12	Canada	Walk score™	CCHS survey	MET/day walking for transport	0,08 h/day	0,26 h/day	1.3	Thielman *et al.* (2015)
	1,287	20 to 65	Seattle, WA & Washington DC, USA	LPA	IPAQ survey	Time used walking for transport	13,7 min/week	160,2 min/week	6.2	Adams *et al.* (2015)
	754	≥18	Alberta, Canada	Cluster-analysis	IPAQ survey	Time used walking for transport	114 min/week	178 min/week	2.7	Jack and McCormack (2014)
	4,034	≥18	Calgary, Canada	Cluster-analysis	NPAQ survey	Time used walking for transport	105 min/week	209 min/week	4.3	McCormack *et al.* (2012)
	227	≥35	Paris, France	Walk score™	GPS and accelero-meters	Steps per 10 min of trip taken	221 steps	415 steps		Duncan *et al.* (2016)
	697	18 to 65	Curitiba, Brazil	GIS walkability index	IPAQ survey	% walk for transport ≥150 min per week	21.1%	35%		Siqueira Reis *et al.* (2013)
	438	≥65	Ghent, Belgium	GIS walkability index	IPAQ survey	Time used walking for transport	42.3 min/week	86.1 min/week	1.8	Van Holle *et al.* (2014)
	2,269	20 to 66	Stockholm, Sweden	GIS walkability index	IPAQ survey	Time used walking for transport	100 min/week	150 min/week	2.1	Sundquist *et al.* (2011)
	2,199	20 to 65	Washington DC, USA	GIS walkability index	IPAQ survey	Time used walking for transport	15.6 min/week	36.2 min/week	0.8	Sallis *et al.* (2009)
	647	≥66	Washington DC, USA	GIS walkability index	IPAQ survey	Time used walking for transport	6.7 min/week	38.1 min/week	1.3	King *et al.* (2011)
	106,337	≥20	Ontario, Canada	Walk score™	CCHS survey	% walk for transport <1 h/week	44.9%	31.1%		Chiu *et al.* (2015)
						% walk for transport 1-5 h/week	30.9%	41.9%		
Time walking for leisure	1,065	≥18	Alberta, Canada	Cluster-analysis	IPAQ survey	Time used walking for recreation	158 min/week	149 min/week	0.4	Jack and McCormack (2014)
	4,034	≥18	Calgary, Canada	Cluster-analysis	NPAQ survey	Time used walking for recreation	182 min/week	198 min/week	0.7	McCormack *et al.* (2012)
	697	18 to 65	Curitiba, Brazil	GIS walkability index	IPAQ survey	% walk for leisure ≥150 min per week	10.5%	13.4%		Siqueira Reis *et al.* (2013)
	438	≥65	Ghent, Belgium	GIS walkability index	IPAQ survey	Time used walking for recreation	77.1 min/week	88.7 min/week	0.5	Van Holle *et al.* (2014)
	2,269	20 to 66	Stockholm, Sweden	GIS walkability index	IPAQ survey	Time used walking for recreation	60 min/week	68 min/week	0.3	Sundquist *et al.* (2011)
	2,199	20 to 65	Washington DC, USA	GIS walkability index	IPAQ survey	Time used walking for recreation	13.3 min/week	16.4 min/week	0.1	Sallis *et al.* (2009)
Time used for MVPA	714	66 to 97	Washington DC, USA	LPA	Accelero-meters	Time used for MVPA	6,9 min/day	11,6 min/day	1.6	Todd *et al.* (2016)
	1,287	20 to 65	Washington DC, USA	LPA	Accelero-meters	Time used for MVPA	32,1 min/day	49,2 min/day	6.0	Adams *et al.* (2015)
	438	≥65	Ghent, Belgium	GIS walkability index	Accelero-meters	Time used for MVPA	90.4 min/week	129.8 min/week	2.0	Van Holle *et al.* (2014)
	2,269	20 to 66	Stockholm, Sweden	GIS walkability index	Accelero-meters	Time used for MVPA	39 min/day	47 min/day	2.8	Sundquist *et al.* (2011)
	357	20 to 70	Atlanta, GA, USA	GIS walkability index	Accelero-meters	% doing ≥30 min of MVPA per day	13%	37%		Frank *et al.* (2005)
	1,798	≥18	Calgary, Canada	Cluster-analysis	Telephone-interviews	MET (18-40 years)	694 min/week	1056 min/week	6.0	McCormack *et al.* (2014)
						MET (41-60 years)	663 min/week	954 min/week	4.8	
						MET (> 60 years)	729 min/week	940 min/week	3.5	
	2,199	20 to 65	Washington DC, USA	GIS walkability index	Accelero-meters	Time used for MVPA	28.5 min/day	34.4 min/day	2.1	Sallis *et al.* (2009)
	647	≥66	Washington DC, USA	GIS walkability index	Accelero-meters	Time used for MVPA	52.2 min/week	69.4 min/week	0.9	King *et al.* (2011)
						% doing ≥150 min of MVPA per week	3.9%	8.6%		

MET, Metabolic Equivalent of Task; GIS, Geographic Information System; CCHS, Canadian Community Health Survey; LPA, Latent Profile Analysis; IPAQ, International Physical Activity Questionnaire; NPAQ, Neighbourhood Physical Activity Questionnaire; GPS, Global Positioning System; MVPA, Moderate Vigorous Physical Activity. *The Δ MET h/week value was calculated multiplying reported physical activity value by the Metabolic Equivalent of Task (MET) definite in (Ainsworth *et al.*, 2011), 2.5 METs for utilitarian and leisure time walking (that is to say, this activities means 2,5 times of energy spent at rest), while was assigned 3 METs for MVPA. °The GIS-walkability index is calculated by measuring the chosen variables in each geographical unit studied and normalising them by z-score. Because both geographical units and variables for the walkability calculation vary between studies, there is no homogeneous index. For example, Frank *et al.* (2010) chose census block groups as a geographic unit, in a corresponding total area of study for a county, being the variables for the calculation intersection density, residential density, floor area ratio and land use mix. After estimating the z-score, for each block group the walkability index was defined as: Walkability = [(2 x z-score for intersection density) + (z-score for net residential density) Area ratio) + (z-score for land use mix)]. Walk Score™ works with a private algorithm based on the distance to the closest amenity in different available categories. It measures walkability of any address assigning a number between 0 and 100.

walking infrastructure, access to recreation facilities and safety from crime (Sallis *et al*., 2011; Sugiyama *et al*., 2015). These factors explain differences between perceived and objectively measured walkability regarding the development of PA (Hanibuchi *et al*., 2015). However, Koohsari and colleagues (2015) suggest that people living in less walkable areas could still perceive them as walkable, and living in more walkable areas could be thought of as less walkable. Thus, safer and more pleasant neighbourhoods can improve the perception of walkability in neighbourhood with a low walkability index.

Some of the factors presented and discussed here are especially important for older adults (Sugiyama and Thompson, 2008; Stathi *et al*., 2012). Given the impact of PA on the prevention and management of diabetes in older people, interventions that focus on improving walkability and related factors may have a particularly good impact on this group considering that walking is the main physical activity performed at this time in life (Crespo *et al*., 1996; Szanton *et al*., 2015). On the other hand, environmental factors can influence the effects of walkability. Air pollution can reverse the positive health effects generated by walkability (Hankey *et al*., 2012). Urban design should focus on generating neighbourhoods with high walkability and low air pollution rates (Marshall *et al*., 2009; Cowie *et al*., 2016). Walkability in turn can influence environmental factors and thus play an additional protective role against diabetes (Figure 1). Air pollution is related to vehicular use (Patil *et al*., 2015), *e.g*., neighbourhoods that encourage walking end up with less car traffic (Frank *et al*., 2006, 2007). If the walkability index is related to fewer vehicle miles travelled, it could indeed contribute to the reduction of air pollution (Frank *et al*., 2006). Interestingly, recent articles have highlighted the fact that air pollutants are significantly associated with increased risk of T2DM (Meo *et al*., 2015; Liu *et al*., 2016a). The social capital is defined as the degree of social collaboration between different groups of a human collective, thereby indicating community engagement (Bjørnskov, 2006). A positive relation exists between walkability and social capital (Rogers *et al*., 2011; Rogers *et al*., 2013) and walkability can foster social capital by favouring social connectedness and people involvement within the local community. Social capital is protective both with regard to obesity and diabetes (Holtgrave and Crosby, 2006). In diabetics, social capital is related to upholding a good control of diabetes treatment as assed by HbA1c levels (Farajzadegan *et al*., 2013; Smalls *et al*., 2015).

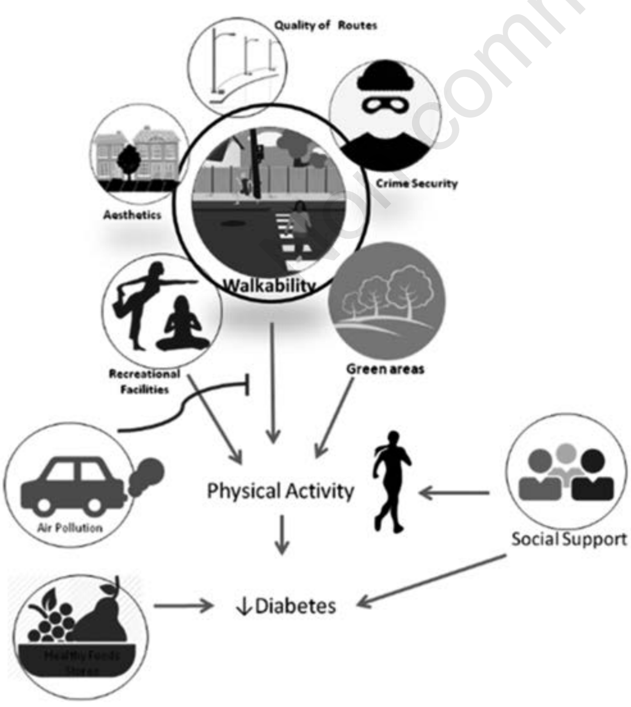

Figure 1. Schematic representation of the relationship between walkability and other factors present in the neighbourhood as determinants of physical activity and diabetes.

Conclusions

The cost of diabetes, considering diagnosis, treatment and loss of productivity, amounts to billions of USD annually. In addition, this expenditure increases incessantly over time. Recent studies suggest that walkability is a protective element for the development of diabetes based on the nexus between walkability and physical activity. It is clear that walkability facilitates reaching recommended levels of PA for the prevention and treatment of diabetes. In this sense, walkability is a parameter that should be considered in urban planning to promote PA and health. Designing neighbourhoods with high levels of transitability through physical activities could contribute to reducing the incidence of diabetes, improving the effectiveness of interventions and also lower spending on health. Additionally, since changes in zoning, urban planning and design, variables of walkability are modifiable (Glazier *et al*., 2014), the benefits of walkability could be applicable even in established neighbourhoods. For this strategy to become effective, it is necessary to consider the relationship between walkability and other factors involved in urban design, as well as socioeconomic and environmental variables, with regard to the PA promotion. However, more studies are needed to fully evaluate the association between walkability and diabetes.

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