INTERNATIONAL JOURNAL OF BUILT ENVIRONMENT AND SUSTAINABILITY
Published by Faculty of Built Environment, Universiti Teknologi Malaysia
Website: http://www.ijbes.utm.my
IJBES 3(1)/2016, 60-69

Effects of Neighborhood's Built Environment on Physical Activities in Gated Communities: A Review

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History:

Received: 15 December 2015
Accepted: 17 January 2016
Available Online: 30 January 2016

Keywords:

Neighborhood, built environment, physical activity, gated community s

DOI:

10.11113/ijbes.v3.n1.111

ABSTRACT

The emergence of gated communities throughout the world has generated significant academic interest. Several studies have been carried out that can be found in the body of literature, which have attempted to investigate the various aspects of life within the gated communities. The range of subjects studied within this context includes the types of gated communities, the associated social and governance issues, the travel patterns, and the daily physical activities. The focus of most of these studies, however, has been on the social and governance issues while a little research on the mobility pattern (i.e. walking, cycling and public transport) and physical activities in gated communities has been reported, the available literature suffers from major shortcomings such as identification of suitable indicators to investigate whether these communities have same effects on mobility patterns and physical activities as non-gated communities. The present paper, therefore, attempts to identify the methods for objective as well as subjective study of the mobility patterns and neighborhoods design which affect the physical activities through a systematic review of available literature. The paper identifies suitable indicators to investigate the rate of physical activity in gated communities. Attempt will be made to clearly chart the differences as well as similarities between the issues concerned with physical activity in gated communities and non-gated communities and attempts to introduce new objectives for future studies. The findings of this study are expected to help design an investigation into the merits or otherwise of the active living neighborhoods.

1. Introduction

1.1 Background

Urging by wellbeing experts and organizations on physical activity (PA) notwithstanding, numerous grown-ups are not sufficiently active to accomplish ideal medical advantages (Bauman, et al., 2011). Therefore, there is a requirement for enhanced systems that support and promote PA at the populace level. In the past 15 to 20 years, there has been a significant increase in the research interest about aspects of the built environment (BE) at neighborhood level supporting PA. In comparison to other approaches promoting health, the adaptation of BE to support PA is more effective and sustainable strategy for encouraging people to increase the levels of PA. This has become robust area of research investigation now (Day & Cardinal, 2007). On the other hand there is another type of neighborhood called gated communities. These communities have recently emerged and gained popularity around the world among consumers. Many social aspects of these communities have been investigated up till now but its effect on mobility patterns and physical activity has not studied that much. So the purpose of this paper is to find out proper indicators for investigating the effects of these communities on physical activity.

In this field of investigation the indicators of neighborhood environment are classified into three important categories such built environment at neighborhood level indicators, social indicators and physical activity facilities. The built environment indicators at neighborhood level are the land use patterns, transportation systems and design features which can affect physical activity (Handy, et al., 2002; Humphrey, 2005). On the other hand Sallis, et al. (2009) concluded that social aspects and sports facilities also affect physical activity at neighborhood level.

Land-use patterns are measured through land-use mix, housing density and connectivity while transportation is measured through the accessibility. The design features are known as aesthetics of the area and are measured though the buildings and streetscapes of neighborhood. Land-use mix is diversity of land-use and provides different destinations to physical activities (Bourdeaudhuij, et al., 2003). In addition, the neighborhood is especially considered important where there is land-use mix because it encourages majority of physical activity, including walking and cycling for different purposes (Giles-Corti, et al., 2008). Similarly the higher housing density is also positively associated with physical activity (Coogan, et al., 2009; Strath, et al., 2007). Connectivity is the third important indicator of land use patterns. It is measured with density of intersections in sqkm or number of cul-de-sacs in a neighborhood. Grid like street patterns for example, is more supportive to walking in contrast with fewer intersections. This is partly because grid-like pattern offers alternative routes to destinations (Li, et al., 2005).Transportation is measured through the accessibility. It is investigated that the access to diverse destinations of both recreational

and utilitarian nature is positively associated with physical activity (McCormack, eta al., 2008). The third important indicator of neighborhood built environment is the design features (aesthetics). Design features are measured through buildings (i.e. attractive facades and maintenance) and streetscape (i.e. shaded pathways, street lights, street furniture etc). The lighting, shade and the presence of street furniture also plays a positive role in this regard (Witten, et al., 2012; McCormack, et al., 2008). There is an association between aesthetical aspects of a neighborhood such as landscaping and cleanliness and leisure walking (Cohen, et al., 2010; Hoehner, et al., 2005).

The social indicators (i.e. perception of crime, physical disorder and traffic) and sports facilities (i.e. parks, gym public pools, jogging tracks etc) also effect physical activity. Lack of personal and traffic safety have been found inversely associated with physical activity (Strath, et al., 2007; Miles, 2008; Weir, et al., 2006). The sports facilities also affect the physical activity at neighborhood level (Bourdeaudhuij, et al., 2015).

1.2 Significance and Objective

The above discussion points to many aspects of neighborhoods which can effect physical activity, however, it is necessary to investigate the physical activity level in a new form of neighborhood, which is growing very fast; the Gated communities (GCs). These are the types of built environments that are walled or fenced from the rest of the communities in a city (Blakely & Snyder, 1997). It emerges about gated communities that the aim of these communities is to provide prestigious life in a secured area. These communities are mostly governed by private home owner associations (Blakely & Snyder, 1997). The property values are very high and, in some cases, it is found that the values increase in the vicinities of gated communities as well if the demand is high (Blandy, 2006). Therefore, it is hard to find mixed economic groups in these communities. It is found in many studies that these communities are creating segregation among gated and non-gated, and social exclusion, for example, general public has no access to parks inside gated communities. At the same time Burke and Sebaly (2001) claim that the streets of gated communities are less walk-able as compared to non-gated as they calculated the number of children playing in street to be less in gated communities. Miao (2003) claims that because of less connectivity of these communities with the rest of the city, the streets near gated communities are deserted in China. Landman (2000) says that these communities are affecting urban sustainability due to fragmentations and separation into small pieces. It is observed that there is lack of research on the physical activity level of these communities to provide appropriate polices to the policy makers.

The aim of this paper is to systematically review the literature on said topic and select appropriate indicators for conducting this research in gated communities.

2. Methodology

The study reviews existing literature on the subjects relevant to the built environment and the associated physical activity. We identified the relevant literature, sorting and screening them based on the relevance, and then do the critical assessment.

2.1 Data Sources & Search Strategy

Computer based search on studies on the effects of neighborhood built environment on physical activity from Active Living Literature, Sage journals and Google Scholar were conducted to examine the English-language literature published between years 2001 and 2015, with the following search terms: built environment, active travel, leisure walk, utilitarian walk, moderate to vigorous physical activity (MVPA) and gated communities. Additional articles that appeared relevant were selected from citation lists of articles identified in the initial search. Specific journals – American Journal of Preventive Medicine, Health and Place, Bio Med, Journal of Physical Activity and Health, Journal of Environmental Heath, Journal of Public Health Policy, American Journal of Epidemiology, Journal of Urban Health, Journal of Planning Education and Research, Journal of Planning Literature– were frequently assessed for relevant articles with the same search criteria.

2.1 Inclusion and Exclusion Criteria

The basic inclusion criteria, was the relations between the built environment of neighborhoods and physical activity in gated communities and non-gated communities. There were only two studies found specifically relevant to this topic, therefore, the screening criteria was expanded to include studies that assessed physical activity more broadly including the effects of neighborhood built environment on physical activity without any specific reference to gated communities. The review articles were excluded from this study. Initially eighty (80) studies were included. Forty eight (48) of those studies that solely used qualitative methods or only discussed socio-economic aspects were not retained for further review. Only those studies that attempted to or did quantitative assessment of built environment with some reference to the associated physical activity were reviewed. The method adopted for this study is, therefore, a qualitative approach to summarize the key aspects in this area.

2.2 Study Sample Characteristics

Once the set of studies to be included in this literature review was finalized, certain characteristics of the study sample emerged. The majority of the studies were conducted in the U.S and a few in other parts of the world like Canada, Australia, Europe, UK, Brazil, New Zealand and Hong Kong, which were included in this study. These studies were published between 2001 and 2015. The mean ages among samples ranged between 18 and 65 years, although a couple of studies (Boone-Heinonen, et al., 2010; Weir, et al., 2006) are about children and adolescents. Most of the samples included both men and women except two, which are solely about women (Coogan, et al., 2009; Kerr, et al., 2104). Studies covered all income groups; a few solely focused on low-income (Neckerman, et al., 2009; Bracy, et al., 2014).

3. Results and Discussion

The effects of different indicators and methods on neighborhood level have been systematically reviewed for this study to identify key indicators for conduction of this study in Gated communities. The list of 31 important literatures which is reviewed for this study is given in Table 1 for reference. The indicators which can affect PA are categorized into three sub-parts like the indicators of built environment at neighborhood level, the social indicators at neighborhood level and physical activity facilities. The details of indicators of 31 studies are as follows.

3.1 Built Environment Indicators

The indicators of neighborhood built environment are classified broadly into three categories such as the land-use patterns, transportation and

design features. The land-use patterns are mainly measured with the land-use mix, housing density and connectivity. These were investigated through many studies and it was identified that there is a mix of results with physical activity. A few studies have concluded that land-use mix is associated with moderate level of physical activity (Frank, et al., 2005; Strath, et al., 2007; Aytur, et al., 2007; Sallis, et al., 2009). On the other hand Wineman, et al. (2014) unexpectedly found that increase in land-use mix was associated with less physical activity. According to them, the land use mix at neighborhood level does not facilitate physical activity as it facilitates at city level. In another study, land-use mix was found positively associated with both leisure and transportation activities (Aytur, et al., 2008). The findings of this study are based on a survey in North Carolina involving more than 6000 survey participants as opposed to the study of Wineman et al. (2014), which was based in Detroit, a low to moderate density city, and the outcomes drawn from it cannot be generalized to other areas, especially metropolis.

Housing density is the second important measure for land-use patterns and many researchers have concluded that there exist co-relations between residential density and different levels of physical activity. It has concluded in four studies (Frank, et al., 2005; Aytur, et al., 2007; Witten, et al., 2012; Sallis, et al., 2009). According to Kerr, et al. (2104) and Coogan, et al. (2009) conclusions the residential density is associated with moderate levels of physical activity in older women. While in the Twin Cities Walking Study, it has been concluded that density is not meaningfully related to overall mean miles walked per day or increased total physical activity (Oakes, et al., 2007). The discrepancy in the outcomes of different studies regarding the association between density and physical activity can be attributed to different factors. Two of the studies reporting a positive relationship, for example, focus on women only (Coogan, et al., 2009; Kerr, et al., 2104). However, the other studies claiming a positive association thereof have used either objective measurement (Frank, et al., 2005) or a wide range of data, from 11 countries (Sallis, et al., 2009), for example. Their findings, therefore, seem to be more reliable compared to the studies denying the relationship, one of which was based in Detroit (Wineman, et al., 2014), a low to moderate density city. The other study denying the positive association between density and physical activity used clustered data sampling, which might have impacted their outcome. (Troped, et al., 2010).

Connectivity is third important indicator of land-use patterns and it is measured by counting the number of intersections in a square kilometer and number of cul-de-sacs in a neighborhood. It is concluded by Frank et al. (2005) that street connectivity is associated with moderate levels of physical activity. Similarly, it has been concluded in another study that neighborhood features alone (i.e. sidewalks, front porches, small set -backs) are not enough for walking or to be physically active but street patterns like fewer cul-de-sacs can play a role for walking and to be physically active (Wells, et al., 2008). Boone-Heinonen, et al., (2010) have concluded that streets connectivity within 1km buffers demonstrates the most association with physical activity. At the same time it is concluded by Giles-Corti, et al.(2008) that neighborhood designs that follow the guidelines for livable neighborhoods are more connected and walk-able and are more physically active than those which do not. Wineman et al. (2014) in their study based in Detroit have also observed if the street is connected within locality and integrated; it creates more walk-able or physically active neighborhoods than less connected streets. So it can be concluded through the above literature about land-use patterns (i.e. land-use mix, housing density and connectivity) has positive association with physical activity at neighborhood level. Therefore, these three measures are needed to be investigated in gated communities because gated communities have shortcomings of land-use mix, housing density and connectivity with other neighborhoods.

Transportation: The indicator of transportation is accessibility to different destinations (i.e. public transport, school and work). It is.measured through the presence and proximity of destinations and destination access. For example Witten et al. (2012) in their study concluded that the three measures including destination access were associated with 7% increases physical activity when it is measured objectively through accelerometer. This is an important indicator for gated communities to be investigated because the accessibility of gated communities is limited. These communities have guarded or gated access to the other areas to their vicinity.

Design Features: The design features of a neighborhood are also known as aesthetics of the area. These are measured through the buildings and streetscape of neighborhoods. Buildings measurements are classified as the attractive facades as well as the maintenance of buildings in a neighborhood. The streetscape of neighborhood is the infrastructure availability, shades paths ways, street lights, benches and hard and soft cape of streets. Strath, et al. (2007) and Craig, et al. (2002) concluded that aesthetics are positively associated with physical activity. Poor neighborhoods having fewer, dirty, less landmark buildings, non-availability of sidewalks and high crime rate are less physically active than affluent areas which have more aesthetics and safety (Neckerman, et al., 2009).It is evident from the above that better accessibility and good design features within neighborhoods are associated positively with physical activity; it is agreed upon by all the studies. This indicator is also an important indicator for investigating physical activity in gated communities because these communities have very attractive and maintained buildings and good streetscape.

3.2 Social Indicators

Social indicators are also found very important in these reviewed studies to effect physical activity. The social indicators are the perception of crime; physical disorder and traffic safety etc. Sallis et al. (2009) concluded that the perceptions of crime have a negative association with physical activity. At the same time it is found in some other studies that high physical disorder (litter, graffiti, lack of greenery) of neighborhood is negatively associated with physical activity (Miles, 2008). Similarly in case of children the inner city children engage in less physical activity than suburban and inner city parents are more concerned about safety of neighborhoods for physical activity of their children (Weir, et al., 2006). Traffic related characteristics like traffic control is found positively associated with active travel (Strath, et al., 2007; Neckerman, et al., 2009). At the same time a significant interaction was observed between number of street intersections and perception of safety from traffic in older adults (Li, et al., 2005). The sense of neighborhood safety is significant and it has been generally concluded that it encourages physical activity through reviewing the above mentioned literature.

3.3 Sports Facilities

Physical activity facilities are also very important indicator to enhance moderate to vigorous physical activity (MVPA) at neighborhood level. It is measured through the availability of sports grounds, indoor games facilities, swimming pools, jogging tracks and public parks etc. Physical activities facilities are positively connected to vigorous activity (Mdpi Ag, 2015). Residential outdoor table tennis courts and public indoor

Table 1: *Summary of Literature Review (1 of 4)*

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
1	Craig et al., 2002	Canada	• No of destinations • Social dynamics • Walking routes • Transportation system • Visual interest • Visual aesthetics • Threats from traffic and crime	PA in 27 neighborhoods of Canada Observational method for BE and Questionnaire for PA and 1996 Canadian census	Cross-sectional Hierarchical linear modeling	Neighborhood aesthetics such as visual aesthetics have positive associations with leisure walk physical activity are important factors
2	Berrigan & Troiano, 2002	US	• The neighborhoods built before 1946 • The neighborhood from 1946-1973 • The neighborhood after 1973 Observations and Objective method of data collection Third National Health and Nutrition Examination Survey data	Nonworking, leisure-time physical activity for 1-mile for 20 times in a month and home age in U.S. adults in urban/suburban and rural areas. Self-reporting (Questionnaire)	Logistic regression was used to estimate odds ratios	Social variables like home age is an important factor because the people who have lived before 1946 and from 1946 -1973 walked more 1mile 20 times per month as *compared to houses built after 1973* but this association was just in urban areas and suburban not in rural counties
3	De Bourdeaudet et al.., 2003	Europe	• Residential density • *Land-use Access to local shopping* • Availability of sidewalks/bike lanes • Neighborhood aesthetics • *Perceived safety from crime and traffic* • Connectivity • Satisfaction with neighborhood and its services Layout plans / survey	• *Sitting time* • Walking • Moderate activity • Vigorous activity International Physical Activity Questionnaire (IPAQ)	Cross-sectional analyses	*Long time sitting of physically inactivity was related to more perceptions of crime and long distance form shopping areas*. Walking was also related to less land-use mix and accessibility to shopping
4	Li, et al., 2005	US	• Neighborhood Vs. Resident level walking/PA • density of places of employment • household density • green and open spaces for recreation • number of street intersections • perception of crime • Recreational facilities Geocoding at neighborhood level	• walking at the resident level, • walking at neighborhood level Self-reporting (Questionnaire)	Cross sectional, multi-level design multistage sampling	At Neighborhood level the density of places of employment, household density, green and open spaces for recreation, number of street intersections were positively associated with walking At resident level the perception of safety, number of recreational facilities nearby was positively associated with PA.
5	Addy et al., 2004	US	• People active in neighborhood • Presence of side walks • Street lighting in neighbors • Use private recreational facilities • Neighbors can be trusted • Community malls • Community parks	Social and environmental support to walking and physical activity Self-reporting (Questionnaire)	Cross-sectional	Good street lighting trusted neighbors and private recreational facilities (i.e. parks, playgrounds, and sports fields), access to malls were positive association with walking and PA at neighborhood level and community level
6	Frank et al., 2005	US	• Land mix of 1sq km of residential, commercial, office • Connectivity • Housing density	Instrumental method the use of accelerometer for 2 days for PA.	Cross-sectional Linear and logistics regression	Land use mix, connectivity and housing density were important for moderate level of physical activity by having >30min/day walk.
7	Hoehner et al., 2003	US	• No. of destinations • No. of recreational facilities • *Side walk/bike lane and public transport present* • Feel safe from traffic • *Neighborhood pleasant* • *Trees along neighborhood* • Free of garbage, litter • safe from crime	Engage in *Any transport activity* Recreational activity MET/did not meet the health recommendation for 30 min/day PA by any of above two Self-Reported (Questionnaire)	Cross-section study of high and low walkability neighborhoods	*Transportation activity was negatively associated with sidewalks and aesthetics* but positive association was with no. of destinations and public transit Recreational activity was positively associated with recreational facilities.
8	Evenson et, al., 2005	US	New trail construction effects on PA • Walking, bicycling and jogging on new trails • People who were living within 2-mile area of multi-trail	10 minutes' walk for any purpose leisure, work or physical activity Self-Reported (Questionnaire)	Quasi-experimental Multi variable logistic models	*No increase in physical activity was found due to new trail.*

Table 1: *Summary of Literature Review (2 of 4)*

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
9	Weir, Etelson & Brand, 2006	US	Low income Inner city and middle class suburban neighborhood parent perception about safety for their children PA • gangs, • child aggression, • *crime,* • traffic and personal safety 20 item Questionnaire was used	Participation of outdoor sports and dance run by school after school Plays/walk/bike outdoors with adults/alone Plays neighborhood park and play grounds	Cross-sectional	*Inner city children were less physically active than suburban children* Inner city parents were much concerned about safety than suburban But inner city children's physical activity levels were negatively correlated with parents perception of safety compared to suburban
10	Strath, Isaacs & Greenwald, 2007	US	• Infrastructure • Land-use • Landscape • Aesthetic *Safety* Ortho-photographs (aerial photographs), Census block information (GIS), field visits were used	Walking and cycling using 15-min walk 10 min cycling from an individual place of residence Self-Reported (Questionnaire)	Cross-Sectional Correlation	Infrastructure, land use, landscape, aesthetics were positively associated with PA *Poorly maintained or missing sidewalk, crosswalks, and bike paths and traffic safety discouraged PA*
11	McCormack, et al., 2008	Australia	• *Destination present* • *Destination mix:* Count of recreational destination Count of utilitarian destination Survey /Plans	walking for transportation walk for recreational vigorous walk (last 2 weeks) Self-Reported (Questionnaire)	Cross-sectional Stratified sampling	Proximity and accessibility were positively related to active transportation *not with leisure walking or vigorous activity*
12	Giles-Corti et al., 2008	Australia	18 livable, 45 conventional and 11 hybrid neighborhood attitude towards PA • No. of recreational destinations within a 15-min walk of home for recreational walk • No. of Transport destinations within 15-min of home mean for transport walk Survey/ Plans	Self-efficacy Social support; walked with family Walk with the dog in neighborhood Instrumental method: use of pedometer for 7 days	Longitudinal quasi-experimental	The neighborhood have livable guideline were more walk able and physically activity than those which were not.
13	Aytur et al., 2007	US	Land-use Mix, non-motorized transportation improvements and implementation tools (30 plans studied) • No mixed-use classification, no NMTI, no implementation tools • Mixed-use classification or NMTI; 0–4 implementation tools • Mixed-use classification and NMTI; moderately comprehensive implementation tool set (1– 4 tools) • Mixed-use classification and NMTI; most comprehensive implementation tool set • NMTI=non-motorized transportation improvements	No. of leisure time PA, Leisure-time walking 150 minutes of leisure-time walking per week. self-reported (Questionnaire)	This cross-sectional study	The neighborhood which had land-use mix, non-motorized transportations improvements and implementations tools were more associated with leisure walk, active travel and even the low income people living in higher county were more physically active for transport. Land-use and transport plans encourage physical activity if they are implemented properly
14	Oakes et al., 2007	US	*Density* Land-use Mix *Connectivity* Street pattern Infrastructure Presence of destinations Safety and interest Plans/questionnaires/interviews	Travel walk Leisure walk Mean mile walked/day Mean total activity count/day Objective method (i.e. Accelerometer for 7 days)	Cross-sectional observational study	Travel walking was associated with PA in higher density neighborhoods Leisure walk was associated with low connectivity *Neither density nor connectivity was associated with mean mile walk /day or mean total activity count/day*
15	Wells & Yang, 2008	US	• Total linear length of street (1/2mile) • No. of street intersections • No. of cul-de-sacs • *Employments/housing and service density* • *Service-job/population ratio* • *Job/residence ratio* • *Land-use mix*	Are there differences in weekly walking between women living in neo-traditional (experimental) neighborhoods and those living in conventional (control group) suburbs Self-reporting (Questionnaire)	Quasi-experiment of cross-sectional and longitudinal data	Women who moved to new places with fewer cul-de-sacs on average walked more but *Unexpectedly land-use mix were associated with less walking* *Neo-Traditional features were negatively associated with PA*
16	Miles, 2008	US	• Land use • *Neighborhood disorder (litter, graffiti,* lack of greenery, traffic disorder) • *Perceived safety* Directly observed by trained surveyors	Encouragement of use of playground by children and level of physical activity Self-reporting (Questionnaire)	Cross-sectional	Neighborhood disorder was associated with adults occasional involvement in sports only among women *Safety was not associated with PA* *Disorder had no association with children use of Playground*

Table 1: *Summary of Literature Review (3 of 4)*

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
17	Neckerman et al., 2009	US	Aesthetic in neighborhood Safety in streets Poor census tracts had significantly	Field survey of poor and non-poor neighborhood Observations	quintile and logistic reg	Improved neighborhood conditions (i.e. aesthetics and safety) was associated to reduce disparities and increase PA
18	Sallis et al., 2009	Hong Kong	• Land-use Mix; many stores around • Residential density • Access to transit • Infrastructure side walk/bike lane • Free/ low cost recreational facility • Perceived crime	• 3 days vigorous-intensity PA for 20 min/day • 5 days moderate level of PA for 30min/day • 5 days for combination 600MET minutes/week Self-Reported (Questionnaire)	Cross-Sectional Logistic regression analysis	Five variables had positive association with PA Low cost recreational facilities to side walk Neighborhood environment had strong potential to effect physical activity
19	Coogan et al., 2009	US	urban form level vs. Individual covariates • Street interconnectedness and traffic • Availability of public transit and buses. • Presence of sidewalks and distance to parks. • *Housing density and average block area* • Intersections density and with 4 ways	*Utilitarian walk* Exercise walk Vigorous walk >5 relative to <5 hours physical activity/week Self-Reported (Questionnaire)	Cross-sectional	Housing density has strongest association with utilitarian walking followed by availability of public transit *Women who were moved to low density 31%decrease in utilitarian walk*
20	Cohen et al. 2010	US	Five intervention parks had been scheduled for major improvements and each intervention park was matched with a similar park (i.e., Comparison Park) which was not planned to receive budget for upgrades by the city.	Self-reporting in two shifts before and after the improvements	Experimental design	*Overall park use declined in both types of parks although the perception of safety increased in intervention than comparison park but this alone was not enough to result in increased park use*
21	Troped et al., 2010	US	• Intersection density(1-km) • Land-use Mix(1-Km) • Population and housing density(1-km) Vegetation Index(1-km) Surveys	Wearable Geo Logger is a GPS device which records speed and position	Cross-sectional Multiple regression model	All had positive association with PA except vegetation index
22	Fitzhugh, Bassett Jr. & Evans, 2010	US	Retrofitting of urban greenway/trail 5 control and 5 intervention neighborhood • Land-use mix • Population density, ethnicity, Intersection connected to 3 or more streets Survey	2 hours of physical activity was directly observed in neighborhood and school children using trial for active travel to school	Quasi-experimental (control group)	*For physical activity there was increase in intervention neighborhood and decrease for control but for active travel to school no difference was noted*
23	MacDonald et al., 2010	US	Body mass index (BMI) Obesity Physical activity levels comparison of these above factors pre - and post-light rail transit (LRT) construction Propensity score weighting approach adjusted for user and non-users of LRT	Public transit use Plan to use LRT LRT usage Self-reported (Questionnaire) and observation	Cross-sectional	The construction of Light transit rail had positive effect on PA and reduction in BMI and obesity.
24	Boone et al., 2010	US	• number of links (street segments • number of nodes (intersections); Intersection density is the number of 3 or more-way intersections/square km. Plans/surveys	Facility counts weighted by the inverse distance from each respondent (facilities between 1 and 8 km)	Negative binomial regression models	PA facilities within 3 km buffers and intersection density within 1k buffers exhibited the most consistent associations with MVPA
25	Bauman et al., 2011	20 countries	Sitting time in 20 countries Age Gender Income group Education Questionnaire	How much time was spend in sitting in weekdays Self-Reporting (Questionnaire)	Cross-sectional	Median sitting time varied widely across countries
26	Witten et al., 2012	New Zealand	• destination access • street connectivity • dwelling density • land-use mix • streetscape quality Plans/surveys	Transport walking Leisure walking Self-Reported (PA at Light, moderate and vigorous level at least 10 minutes) Objective Method (accelerometer 7 days)	Cross-sectional multilevel regression analyses	Street connectivity was associated with leisure PA. Destination accessibility was associated with transport walking. Street connectivity, destination access, dwelling density with self-reported and objectively measured PA had strong association for moderate level PA
27	Kerr et al., 2014	US	Land use mix was calculated as the evenness of the distribution of acreage Residential Commercial Office Institutional land (spatial data of census)	Recreational walking Moderate recreational PA Strenuous recreational Self-Reporting - World Health Improvement (WHI) (Questionnaire)	Linear regression	Total walking was associated to walkability index of half mile (recreation facility, density and distance to coast *Total physical activity was negatively associated with distance to coast and positively with recreational facilities*

Table 1: *Summary of Literature Review (4 of 4)*

No	Author/Year	Country	Built Environment (BE) variables at neighborhood level	Physical Activity (PA) variables	Research methods	Outcome
28	Wineman et al., 2014	US	• high density: • *Land use mix:* • Street network Integration Plans/survey	Physical Activity (MET minutes) Transportation Physical Activity (MET minutes) Leisure Physical Activity Overall (MET minutes) Transportation + Leisure Self-Reported (Questionnaire)	Correlation	*Independent predictors, higher density and multiple land-uses tended to were not that much effective to encourage walking.* However residents of neighborhoods with strong well connected streets networks have high walkability as compared to those which have less connectivity
29	Dill et al., 2014	US	Pre- post installation of bicycle boulevard Rain Being women Living closer to down town Attitudes towards bicycle Walking and car safety Education(4-year of college degree) Married Mean age (35-44) BMI (body Mass Index =height x weight)	>10 min bicycle >20 min walk Physical activity and active travel Objective Method (i.e. Accelerometer and GPS was worn for 5 days)	Natural experiment Multivariate regression model	*No correlations was found in experimental area with MVPA and active travel* *Study could not confirm an increase in physical activity or active transportations among adults with children living near newly installed bicycle boulevards*
30	Bracy et al., 2014	US	A GIS-based walkability index was calculated for a street-network buffer around each participant's home • Perceived crime • Traffic • Pedestrian safety	Total physical activity measured using accelerometers Transportation and leisure walking measured with self-reports (IPAQ-long).	Exploratory analyses used two cross-sectional	*No evidence that safety concerns reduced the beneficial effects with physical activity outcomes, possibly because pedestrian safety items (cross walks, sidewalks) were not as subjective as those on crime and traffic safety*
31	Health gov, 2015	Hong Kong	Number of neighborhood recreational facilities (indoor and outdoor, public and residential) Observations and Geographical Information System data	Objective method (i.e. ActiGraph accelerometers for >= 4 days)	Correlation	The number of public recreational facilities was associated with the corresponding facility perceptions but the size of effect was generally lower than for residential facilities

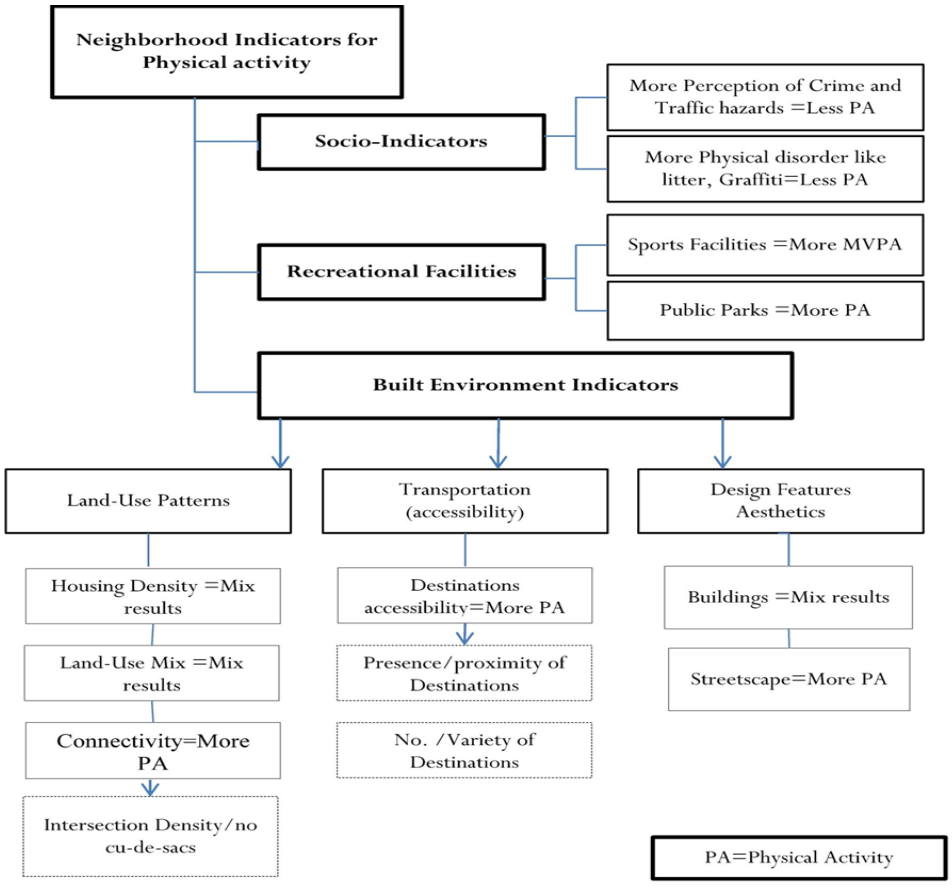

Figure 1: *Indicators of Built Environment at Neighborhood level*

swimming pools, the observationally-assessed presence of tennis courts and swimming pools, and the perceived presence of bike lanes and swimming pools were positive determinants of MVPA. Sallis et al. (2009) have also concluded that presence of free or low cost recreational facilities is positively associated with physical activity. Parks located within 1-mile radius from homes are positively related to physical activity in older women according to Addy, et al., (2004). Most of the studies reviewed have shown positive association between physical activity facilities and physical activity. However, a study has concluded that improvements to parks may not automatically result in increased use and physical activity (Cohen, et al., 2010).It can be broadly concluded through literature review that sports facilities whether indoor or outdoor have positive association with moderate to vigorous physical activity at neighborhood level and gated communities provide many sports facilities to attract many people attention towards them. The details of above discussed indicators are given in the Figure 1.

4. Conclusion

It is concluded that most of the indicators like indicators of neighborhood built environment, social indicators, and physical activity facilities at neighborhood level affect physical activity to some extent. The promotion of walking and vigorous activities is contributions of built environment at neighborhood level to facilitate not only moderate to vigorous physical activity (MVPA) but also to bring about the behavior change among individuals and communities.

The measures of land use patterns of built environment like land-use mix and housing density show mix results on physical activity while the connectivity represented positive association on physical activity. Similarly transportation, the second important indicator of built environment, which is measured through accessibility also affect positively to physical activity at neighborhood level. Design features are the third important indicator of built environment, which is measured through building and streetscape. Buildings have mixed effects on physical activates in neighborhoods while streetscape has positive association with physical activity.

Social indicators are the perception of crime and physical disorder which affect physical activity at neighborhood level. If there is more perception of crime, there will be less physical activity. Same is the case with physical disorder (litter and graffiti). When there is more litter and graffiti, there will be less physical activity.

Finally the physical activity facilities like sports grounds, gyms and jogging tracks also play a vital role in moderate to vigorous physical activity. If the neighborhood has physical activity facilities, the residents will be more physically active.

5. Recommendations

From the review of the literature, following recommendations are summarized for future research on gated communities.

It has been generally concluded by researchers that the land-use patterns (i.e. Land-use mix, housing density and connectivity) promotes physical activity. This conclusion may suggest that physical activity levels are expected to be lower in gated communities, where the land use is seldom mixed, housing density is low and there are dead end streets in gated communities. However, this needs to be investigated along with exploration of other factors that may be involved.

The second important indicator for built environment is accessibility of gated communities. It is needed to be investigated how the limited accessibility with its vicinity of these communities affect physical activity.

The design features at neighborhood level like building and streetscape which can affect physical activity. this is a very important feature of gated communities to attract people through aesthetics of the area. Therefore this needs to be investigated that whether the aesthetics of gated communities has increased physical activity of the residents of gated communities.

Social indicators like the sense of neighborhood safety and traffic safety are significant, and it has been generally concluded that it encourages physical activity. It is expected that the safety perception is found more in the gated communities because it is the main objectives of gated communities for coming into existence; hence increased levels of physical activity should be observed. An investigation is required in this regard.

Finally the physical activity facilities like gym, jogging tracks, sports facilities also encourage moderate to vigorous physical activity (MVPA) and it is found that gated communities provide more physical activity facilities as it is one of the marketing tools of these communities to be popular so the effects of these facilities on PA among the residents of gated communities need to be investigated.

Acknowledgements

The first author acknowledges the National University of Science and Technology (NUST), Pakistan for funding her PhD studies; and all the authors acknowledge University Teknologi Malaysia (UTM) for providing the necessary environment and facilities that made this research possible.

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