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Who moves in vulnerable Caribbean neighborhoods? Positive deviance for physical activity: Findings from the Jamaica health and Lifestyle Survey 2017 (JHLS III)

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ABSTRACT

Decreased physical activity (PA) has been associated with residents living in neighborhoods perceived as being disordered or having high crime levels. What is unknown are the characteristics of individuals who engage in moderate to vigorous levels of PA (MVPA) despite living in these vulnerable neighborhoods, or who may be referred to as positive deviants (PD). We examined the factors associated with PD for PA among Jamaicans. Between 2016 and 2017 the Jamaica Health and Lifestyle Survey, a cross-sectional nationally representative survey (n = 2807), was conducted on individuals aged 15 years and older. Regression analyses were performed to identify associations with PD, defined using engagement in MVPA among persons living in vulnerable neighborhoods (N = 1710). Being female (odds ratio [OR]a = 0.64 (0.48, 0.86); p = 0.003), obese while living in an urban area (ORa = 0.39; 95 % CI = 0.26, 0.59; p < 0.0001), unemployed (ORa = 0.53; 95 % CI = 0.39, 0.73; p < 0.0001), or a student (ORa = 0.62; 95 % CI = 0.39, 0.98); p = 0.041) was associated with a significantly lower likelihood of PD, while having a personal medical history of at least one chronic disease significantly increased likelihood (ORa = 1.43; 95 % CI = 1.08, 1.90; p = 0.014). Taking a PD approach may be one angle to consider in trying to determine what is working and for whom, so that this may be harnessed in policy, prevention and intervention programming to increase PA.

1. Introduction

Many countries continue to explore ways in which their populations can increase physical activity (PA), given its recognition as a modifiable risk factor of Non-Communicable Diseases (NCDs), including obesity (Global action plan on physical activity, 2018). Physical inactivity is of great concern to policymakers in Jamaica, an upper middle-income and small island developing state within the Caribbean. Increases in physical inactivity have been noted in successive nationally representative surveys of persons 15 years and older (Wilks et al., 2008). For example, the third Jamaica Health and Lifestyle Survey (JHLS III) completed in 2017, documented increased prevalence of low physical activity levels (PALs) in both sexes (female: 82.6 %; male: 80.5 %) over the 2008 JHLS II prevalence (female: 74.5 %; male: 67.6 %), and just over half the population indicated never making an attempt to increase PALs (Wilks et al., 2017). Such trends, however, revealed no significant age or urban/rural differences (Wilks et al., 2017).

Globally, neighborhood characteristics have been shown to be

Abbreviations: BMI, Body mass index; IPAQ, International Physical Activity Questionnaire; JHLS, Jamaica Health and Lifestyle Survey; PA, Physical activity; PALs, Physical activity levels; PD, Positive Deviance; MVPA, Moderate to vigorous physical activity; NCD, Non-Communicable Disease; USA, United States of America.

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associated with health outcomes, including PALs (Diez Roux and Mair, 2010; King et al., 2011; Schulz et al., 2013). Sallis et al have proposed ecological models of health behavior positing that PA is influenced by the interplay of individual, environmental, psychological factors (Sallis et al., n.d.). Most studies have been conducted in developed countries such as the United States of America (USA), United Kingdom, Australia and Belgium (Van Dyck et al., 2012) with inconsistent findings of sex differences for associations between the residential environment and health outcomes (Stafford et al., 2005). Additionally, the few studies found from large continental developing countries within Africa and Latin America revealed results that were comparatively inconsistent to those of the developed countries, suggesting limited generalizability (Oyeyemi et al., 2011; Parra et al., 2011). Previous studies conducted in Jamaica have revealed positive correlations between highly disordered neighborhoods and negative health outcomes (Felker-Kantor et al., 2016; Cunningham-Myrie et al., 2015). For example, secondary analysis of the JLHS II found significant clustering at the neighborhood level for low/no PA. Additionally, greater levels of neighborhood disorder, home disorder and counter intuitively recreational space availability, were associated with higher levels of low/no PA among women (Cunningham-Myrie et al., 2015).

In studies in the USA and Jamaica, physical and social environmental barriers to PA have been identified across the lifespan, including proximity and access to recreational facilities, neighborhood safety and disorder (both physical and social) which are also linked with a perception of safety (Douglas et al., 2018; Cunningham-Myrie et al., 2019). However, the association is not consistent, as other studies in the USA have reported opposite or no associations (Bauman et al., 2012). With respect to crime as a specific exposure, in general, both perceived safety from crime (positively) and objective crime (negatively) are associated with PALs (Rees-Punia et al., 2018). However, inconsistencies in directionality and level of statistical significance have also been reported between gender, age, urbanicity and neighborhood crime in their association with PA. For example, among women in the USA, a cohort study involving participants across 50 states found that despite varying by level of sprawl, statistically significant negative associations were seen between perceived crime and PA in all regions (Troped et al., 2011). Nationally representative data from the USA also revealed that exposure to high levels of neighborhood crime was associated with lower engagement in PA among aadolescent girls and not boys (Chaparro et al., 2019). Among adults, a study conducted on low-income African American adults found that neighborhood crime was not associated with moderate to vigorous physical activity (MVPA) overall or in sex and age subgroups (Richardson et al., 2017). On the other hand, perceived safety from crime was strongly correlated with health-related PA among Brazilians in the daytime (Weber Corseuil et al., 2012) as well as, among Nigerians during the nighttime (Oyeyemi et al., 2012) and in older Nigerian adults (Oyeyemi et al., 2019). Other sociodemographic moderators have also been investigated. In a study comprised of majority non-Hispanic white participants in the Maryland–Washington DC and Seattle–King County, Washington metropolitan areas in the USA, interactions involving crime safety showed nonsignificant positive trends in the more affluent/advantaged and women, and nonsignificant negative trends in the less affluent/advantaged group and men (Carlson et al., 2014).

Crime rates in Jamaica are among the highest in the world (Harriott and Jones, 2016) and many neighborhoods are physically and socially disordered (Wilks et al., 2017). Gaps remain regarding understanding how crime plays a role in PA in Jamaica. One approach to this understanding is to examine individuals who engage in PA despite living in high crime areas. Positive deviance (PD) is an inductive approach to problem solving that seeks to identify individuals who achieve successful outcomes despite adverse environments and risk factors also shared by others in their communities (Stuckey et al., 2011; Bradley et al., 2009). Globally, information garnered using this approach, which includes identification of enabling processes or behaviors, has been successful in addressing varied health concerns, such as malnutrition (Mackintosh et al., 2002), obesity (Stuckey et al., 2011; Kraschnewski et al., 2011; Foster et al., 2018), long-term PA maintenance (Kinsey et al., 2019) and among underserved populations (Timmerman, 2007). It is believed that positive deviant behaviors are more likely to be acceptable, accessible, affordable and sustainable within communities (Marsh and Schroeder, 2002).

The purpose of this exploratory paper is to identify and characterize factors associated with being a "positive deviant" (PD) based on PALs in a nationally representative sample of Jamaicans. Specifically, these are Jamaicans who engage in MVPA that live in neighborhoods perceived as having a) high crime and safety problems or b) are physically disordered or c) are socially disordered. The knowledge gleaned may hold clues to a better understanding of ways to target neighborhood level interventions that could increase PA.

2. Material and methods

2.1. Study design and sample

Data were obtained from the JHLS III, a community based, cross-sectional interviewer-administered survey of non-institutionalized Jamaican residents (n = 2807) aged 15 years and older. It was conducted between September 2016 and March 2017 and had a response rate of 92.2 %. The survey determined the prevalence of NCDs and risk factors. The questionnaire was pretested and then administered by trained interviewers. Recruitment of participants was done by conducting a stratified, random, two-stage cluster survey to obtain a nationally representative sample. The neighborhood was defined using our primary sampling unit which consisted of two or more contiguous enumeration districts which have a minimum of 80 dwellings (Wilks et al., 2017). The subset of participants living in vulnerable neighborhoods was identified from the overall dataset and was utilized as this analytic sample (n = 1710).

Defining Vulnerable Neighborhoods. Given the inverse relationship between neighborhood crime and disorder with PAL (Cunningham-Myrie et al., 2015; Rees-Punia et al., 2018), vulnerable neighborhoods were those classified as being perceived by participants as having high crime and safety problems or physical or social disorder (Elo et al., 2009); based on summary scores for all subscales being at or above the 75th percentile. Perception of crime and safety problems was measured by seven questions regarding how worried the respondent was about crime and drug activity in their neighbourhood. These included concerns about whether drug dealers/users were hanging around, property being stolen, walking alone in the daytime, letting children go outside during the day or night and being robbed or murdered. Perceptions of physical disorder were measured based on five questions measuring whether litter/trash, graffiti on buildings, abandoned cars, vacant buildings and houses and yards not being kept up were "a problem" in the neighborhood. Perceptions of social disorder were assessed using four questions regarding a perception of a "problem" in the neighborhood concerning unemployed adults, public drunkenness, young adults hanging around and gang activity.

2.2. Measures

The primary outcome, PD, was attributed to study participants living in vulnerable neighbourhoods, who engaged in MVPA, based on the short form International Physical Activity Questionnaire (IPAQ) (IPAQ Research Committee, 2005; International Physical Activity Questionnaire, 2021). Non-positive deviants lived in vulnerable neighbourhoods but did not engage in MVPA.

Sociodemographic variables considered as factors that may be associated with being a PD included age, sex, education, urban/rural, occupation, relationship status, employment and household-level no. of possessions as a proxy for socioeconomic status. Additionally, body mass

index (BMI) was calculated as weight/height^2 based on anthropometric measurements obtained by the trained interviewers. Weight was measured using calibrated electronic scales (Tanita® models HD 314 or 2204) to 0.1 kg precision and height using a portable stadiometer (Seca®) to 0.1 cm precision. Persons were classified as obese if the BMI $\geq$ 30 kg/m^2. Other covariates include personal and family history of NCDs, alcohol use, satisfaction with life and depression. Depression was defined as the presence of 5 or more symptoms of depression and/or expressions of suicidal ideation based on the Diagnostic and Statistical Manual of Mental Disorders versions 4/5 (DSM 5) (American Psychiatric Association, 2013). Age, sex and urban-rural residence were also considered as potential moderators of the relationship between the other variables with the outcome.

Collective efficacy, one component of social capital, was also assessed and measured the mutual trust and shared expectations among neighbors or communities. It is measured using two subscales 1) social cohesion, the relationships between neighbors and 2) informal social control, community pressure for norms and laws. These two subscales used represent a minor adaptation of the original and validated scale by Sampson et al (Sampson et al., 1997). Study participants were classified as living in a community with high collective efficacy if their collective efficacy score was in the 3rd tertile of scores for the sample (scores ranging from 41 to 50).

2.3. Ethical considerations

The study protocol received approval from the Ethics Committees of the University of the West Indies, Mona Campus, Jamaica and the Ministry of Health & Wellness, Jamaica. The study met the institution's guidelines for protection of human subjects concerning their safety and privacy.

2.4. Statistical analysis

Some 62 % of Jamaicans 15 years and older were residents of communities perceived to be vulnerable, with no sex difference noted. Subsequent analyses of the data were restricted to these Jamaicans. Analyses included descriptive summaries, assessment of bivariate associations and multi-variable regression models with all parameter estimates corrected for the survey's complex sampling design. Descriptive data analysis estimated total survey-weighted proportions with 95 % confidence intervals as well as by PD status and sex. Crosstabulations were subjected to the Pearson's chi-squared test corrected for survey design to determine whether the total or sex-specific prevalence of PD status differed with respect to sociodemographic and other characteristics. The initial logistic regression models produced unadjusted estimates for terms for interaction between each age category, sex of respondent and area of residence (urban or rural), and each of the other explanatory variables specified in Section 2.2 that were significantly associated with PD at $p < 0.2$ in bivariate analysis (Hosmer and Lemeshow, 2000). Logistic regression models with the unadjusted interaction terms significant at the 20 % significance level were further compared using the F-adjusted mean residual test (Archer and Lemeshow, 2006). For each effect modifier, the selected models with the lowest test statistic for the F-adjusted mean residual test were used to build models adjusted for the explanatory variables associated with the positive deviant status at the 20 % significance level in bivariate analysis. Adjusted estimates for interaction terms were then obtained from models with these additional explanatory variables. The models with a single effect modifier were also compared with a model holding all three interaction terms along with additional explanatory variables (not represented in the interactions) but which were associate with PD in bivariate analyses. After using the results of the F-adjusted mean residual test to compare models, the adjusted Wald test statistics were used to determine whether variables with p-values > 0.2 individually or collectively significantly improved model fit. The variables were removed from the model if the corresponding Wald test statistics had p-values > 0.2. The final best model would be one with term(s) for interaction statistically significant at the 10 % level and with test statistic for the F-adjusted mean residual test being the lowest of the set of models compared. Data were analysed using Stata software version 17.0 (StataCorp, College Station, Texas).

3. Results

Tables 1a and 1b shows the total and sex-specific distribution of sociodemographic and cardiovascular disease risk factor categories within PD status categories among this subset of Jamaicans. Table 1a shows that the sub-population of Jamaicans had 78.3 % between the ages of 18–59 years, 50.4 % were male and 51.8 % resided in urban areas. Secondary or higher level of education had been attained by 76.0 % and 56.8 % were employed. Of the 9.7 % that were students, 87.6 % were in the 15–17 years age group (results not shown). Just under one-third (29.5 %) were obese and almost one-fifth (17.0 %) were depressed. Almost two-thirds of the population (65.3 %) were positive deviants. Most participants (56 %) perceived their vulnerable neighborhoods as having low collective efficacy (collective efficacy score $\leq$ 40). The data gave evidence of association of PD status with sex of participant ($p < 0.001$), employment status ($p < 0.001$), nutritional status ($p < 0.05$), depression ($p < 0.05$), and collective efficacy ($p = 0.001$). For the variable defining obesity status the sex-specific associations with PD status were statistically significant (M($p = 0.018$), F($p = 0.004$)). Compared to non-positive deviants a significantly lower proportion of PDs were classified as unemployed (28.3 % vs 43.6 %), obese (24.8 % vs 39.0 %), combined overweight and obese (51.9 % vs 59.9 %), depressed (14.9 % vs 20.9 %) while the converse was true for high collective efficacy (PD: 28.2 % vs Non-PD: 19.7 %).

The data in Table 1b suggest that the associations seen in the total population were driven by the association existing among the females for the variables employment status ($p = 0.0005$), family history of disease ($p = 0.0016$), and community collective efficacy ($p = 0.011$).

To mitigate the effects of small sample size in a category on the precision of parameter estimates based on interaction terms in regression models, in particular, subsequent analyses will use the age variable as having two categories – 15 to 59 and 60 years and older, while persons whose education level was denoted as "other" will be excluded from analyses.

Table 2 shows the sex-specific and total population prevalence (%) of PD status by socio-demographics and risk factor categories and also provides corresponding within-group p-values. Sex-specific and/or total population statistically significant association ($p < 0.05$) with PD status was identified for age group, area of residence, employment status, obesity status, overweight status depression and high collective efficacy. Table 2 also shows that prevalence of PD at the 20 % significance level, differed with respect to sex, age group, area of residence (urban vs rural), education, employment, obesity, overweight status, alcohol use, depression category and collective efficacy category. To assess the respective roles of sex, age group and area of residence (urban vs rural) as effect modifiers, interaction between these variables and each of the remaining forenamed variables was assessed using a binary logistic regression model with PD as the outcome variable.

Table 3 shows the variables that interacted with the respective candidate effect modifiers yielding coefficients representing the interaction with p value < 0.2. Models with the interactions between sex and education, age and alcohol use, and area of residence and obesity had the lowest goodness-of-fit statistic with, correspondingly, the highest p–values. The models with these three interaction terms can be deemed to have the best fit, relative to the other models represented in Table 3.

A single model was then created having as explanatory variables these three interaction terms along with the remaining variables (not represented in the interaction terms) that were associated with PD at the 20 % significance level. The model was improved by removal of terms

Table 1a
Weighted percentage distribution (with 95% CI in brackets) for sociodemographic and CVD risk factors by Positive Deviance status among who perceive themselves as living in vulnerable neighborhoods, Jamaica Health and Lifestyle Survey 2017 (JHLS III).

Characteristics	N	Total (95 % CI)	Positive Deviance (95 % CI)	Non-Positive Deviance (95 % CI)	p-value[1]
Age-groups (years)					
15–17	62	7.6 (6.1, 9.6)	7.9 (5.9, 14.7)	7.1 (5.0, 10.2)	0.154
18–59	1242	78.3 (76.8, 79.8)	79.4 (76.7, 82.0)	76.0 (72.2, 79.5)	
60+	406	14.1 (13.2, 15.1)	12.7 (11.3, 14.2)	16.8 (14.3, 19.7)	
Sex					
Male	661	50.4 (48.9, 51.8)	56.4 (54.1, 58.7)	39.0 (34.2, 44.0)	**<0.001**
Female	1049	49.6 (48.2, 51.1)	43.6 (41.3, 45.9)	61.0 (56.0, 65.8)	
Region of residence					
Urban	762	51.8 (44.6, 58.8)	49.2 (41.0, 57.3)	56.7 (48.4, 64.5)	0.081
Rural	948	48.3 (41.2, 55.4)	50.9 (42.7, 59.0)	43.4 (35.5, 51.6)	
Education level					
<High school	512	21.6 (19.5, 23.9)	22.3 (19.4, 25.5)	20.4 (16.8, 24.5)	0.063
≥High school	1146	76.0 (73.8, 78.1)	76.0 (72.9, 78.8)	76.0 (71.9, 79.7)	
other	38	2.4 (1.9, 3.0)	1.7 (1.1, 2.6)	3.6 (2.9, 4.5)	
Number of possessions					
1st tertile (0–5 items)	599	29.9 (26.9, 33.1)	31.0 (26.9, 35.4)	27.9 (23.4, 32.9)	0.582
2nd tertile (6–9 items)	643	39.3 (36.4, 42.4)	39.1 (35.8, 42.5)	39.8 (34.9, 44.9)	
3rd tertile (10–20 items)	461	30.8 (27.5, 34.2)	29.9 (26.4, 33.8)	32.3 (26.2, 39.0)	
Employment class					
Employed	901	56.8 (53.9, 59.5)	62.3 (59.1, 65.3)	46.3 (40.6, 52.1)	**<0.001**
Unemployed	682	33.6 (30.3, 36.9)	28.3 (25.3, 31.5)	43.6 (37.6, 49.8)	
Student	92	9.7 (8.0, 11.7)	9.5 (7.2, 12.3)	10.1 (7.6, 13.3)	
Satisfied with life					
No	198	17.8 (15.1, 21.0)	17.4 (14.1, 21.4)	18.7 (14.8, 23.3)	0.651
Yes	953	82.2 (79.0, 84.9)	86.6 (78.6, 86.0)	81.3 (76.8, 85.2)	
Nutritional status					
Non-obese	1023	70.5 (67.7, 73.2)	75.2 (72.2, 78.0)	61.0 (55.9, 65.9)	**<0.001**
Obese	488	29.5 (26.9, 32.3)	24.8 (22.0, 27.9)	39.0 (34.1, 44.1)	
Underweight/Normal	640	45.5 (42.0, 48.9)	48.1 (44.1, 52.2)	40.1 (34.4, 46.1)	**0.027**
Overweight/Obese	871	54.6 (51.1, 58.0)	51.9 (47.8, 55.9)	59.9 (53.9, 65.6)	
Alcohol Use					
Never	652	32.9 (30.3, 35.6)	30.4 (27.2, 33.8)	37.7 (32.7, 43.0)	0.066
Former drinker	253	10.9 (9.1, 12.9)	10.5 (8.6, 12.9)	11.5 (9.1, 14.4)	
Past year drinker	150	11.1 (9.3, 13.3)	11.4 (9.0, 14.3)	10.7 (7.9, 14.7)	
Current drinker	620	45.1 (41.9, 48.4)	47.7 (43.3, 52.2)	40.1 (34.9, 45.6)	
Depression					
No	1412	83.1 (80.3, 85.5)	85.1 (81.6, 88.0)	79.2 (74.1, 83.5)	**0.034**
Yes	296	17.0 (14.5, 19.8)	14.9 (12.0, 18.4)	20.9 (16.5, 25.9)	
Family history of disease[¥]					
No	345	20.6 (18.2, 23.2)	20.8 (17.9, 24.1)	20.2 (17.2, 23.7)	0.780
Yes	1347	79.4 (76.8, 81.8)	79.2 (75.9, 82.2)	79.8 (76.3, 82.4)	
Medical history of chronic illness					
No	537	36.0 (32.9, 39.2)	36.5 (32.9, 40.3)	35.0 (30.3, 40.0)	0.606
Yes	1172	64.0 (60.8, 67.1)	63.5 (59.7, 67.1)	65.0 (60.0, 69.7)	
Collective efficacy					
Low	718	74.6 (71.1, 77.8)	71.8 (67.4, 75.9)	80.4 (76.2, 83.9)	**0.001**
High	242	25.4 (22.2, 29.0)	28.2 (24.1, 32.6)	19.7 (16.1, 23.8)	
TOTAL		**100.0**	**65.3 (61.3, 69.0)**	**34.7 (31.0, 38.7)**	

Notes: CI – Confidence Interval.
Statistically significant p-values in bold.
[¥] Family history of disease = Chronic non-communicable disease and cancer.
[1] p-values for association of characteristics with Positive Deviance status in males and females combined.

Table 1b

Sex-specific weighted percentage distribution (with 95% CI in brackets) for sociodemographic and CVD risk factors by Positive Deviance status among who perceive themselves as living in vulnerable neighborhoods, Jamaica Health and Lifestyle Survey 2017 (JHLS III).

Characteristics	Male			Female		
	Positive Deviance (95% CI)	Non-Positive Deviance (95% CI)	p-value[2]	Positive Deviance (95% CI)	Non-Positive Deviance (95% CI)	p-value[3]
Age-groups (years)						
15 - 17	7.6 (4.5, 12.5)	8.1 (4.4, 14.6)	0.758	8.3 (5.6, 12.2)	6.5 (3.9, 10.8)	0.143
18 - 59	78.9 (74.6, 82.5)	75.6 (68.4, 81.6)		80.2 (76.5, 83.4)	76.3 (72.1, 80.1)	
60+	13.6 (11.4, 22.4)	16.3 (11.6, 22.4)		11.5 (9.6, 13.6)	17.2 (14.6, 20.1)	
Area of residence						
Urban	49.8 (42.0, 57.6)	60.9 (50.7, 70.3)	0.081	48.3 (38.4, 58.3)	53.9 (44.5, 63.1)	0.216
Rural	50.2 (42.4, 58.0)	39.1 (29.7, 49.3)		51.7 (41.7, 61.6)	46.1 (36.9, 55.5)	
Education level						
<High school	23.8 (19.1, 29.4)	26.9 (20.1, 34.8)	0.133	20.3 (17.1, 24.0)	16.3 (12.6, 20.6)	0.267
≥High school	75.4 (69.9, 80.2)	69.0 (61.1, 75.9)		76.7 (72.3, 80.6)	80.5 (76.1, 84.3)	
other	0.7 (0.4, 1.5)	4.2 (2.9, 5.9)		2.9 (1.7, 5.0)	3.2 (2.4, 4.3)	
Number of possessions						
1st tertile (0-5 items)	31.9 (27.1, 37.1)	30.7 (23.2, 39.4)	0.157	29.8 (24.0, 36.4)	26.1 (21.0, 32.0)	0.143
2nd tertile (6-9 items)	41.3 (36.1, 46.8)	33.1 (25.7, 41.4)		36.2 (31.5, 41.2)	44.1 (39.1, 49.3)	
3rd tertile (10-20 items)	26.8 (22.2, 31.9)	36.2 (26.0, 47.9)		34.0 (28.2, 40.4)	29.8 (24.5, 35.6)	
Employment class						
Employed	70.2 (65.1, 74.9)	59.2 (48.4, 69.2)	0.180	52.0 (47.4, 56.6)	38.0 (32.8, 43.5)	**<0.001**
Unemployed	21.3 (17.5, 25.5)	31.1 (21.7, 42.4)		37.3 (33.1, 41.7)	51.6 (45.8, 57.4)	
Student	8.6 (5.3, 13.6)	9.7 (5.5, 16.4)		10.6 (7.7, 14.5)	10.4 (7.3, 14.7)	
Satisfied with life						
No	17.4 (14.0, 21.3)	22.8 (15.9, 31.4)	0.216	17.5 (12.8, 23.6)	16.5 (11.8, 22.8)	0.783
Yes	82.6 (78.7, 86.0)	77.3 (68.6, 84.1)		82.5 (76.4, 87.2)	83.5 (77.2, 88.2)	
Nutritional status						
Non-obese	84.5 (79.6, 88.4)	74.4 (63.9, 82.7)	**0.018**	63.7 (59.4, 67.7)	51.9 (45.7, 58.0)	**0.004**
Obese	15.5 (11.6, 20.4)	25.6 (17.3, 36.1)		36.3 (32.3, 40.6)	48.1 (42.1, 54.3)	
Underweight/Normal	60.9 (55.2, 66.3)	54.4 (42.6, 65.7)	0.280	32.3 (27.0, 38.0)	30.4 (24.4, 37.1)	0.679
Overweight/Obese	39.1 (33.7, 44.8)	45.6 (34.4, 57.4)		67.8(62.0, 73.0)	69.6 (62.9, 75.6)	
Alcohol Use						
Never	18.0 (13.6, 23.4)	22.1 (15.2, 31.2)	0.672	46.4 (41.1, 51.8)	47.6 (41.5, 53.8)	0.957
Former drinker	9.5 (7.2, 12.4)	10.3 (6.5, 15.8)		11.9 (9.3, 15.2)	12.3 (9.2, 16.2)	
Past year drinker	9.9 (7.1, 13.5)	8.4 (5.2, 13.2)		13.3 (10.3, 17.1)	12.2 (8.4, 17.4)	
Current drinker	62.6 (55.1, 69.6)	59.2 (49.7, 68.1)		28.4 (24.0, 33.2)	28.0 (23.0,33.6)	
Depression						
No	90.1(85.9, 93.2)	82.9 (74.2, 89.1)	0.065	78.6 (73.5, 83.0)	76.7 (71.0, 81.6)	0.603
Yes	9.9 (6.8, 14.2)	17.1 (10.9, 25.9)		21.4 (17.0, 26.5)	23.3 (18.4, 29.0)	
Family history of disease[¥]						
No	26.4 (22.0, 31.3)	20.9 (15.1, 28.2)	0.183	13.6 (10.5, 17.5)	19.8 (16.0, 24.3)	**0.016**
Yes	73.6 (68.7, 78.1)	79.1 (71.8, 84.9)		86.4 (82.5, 89.5)	80.2 (75.7, 84.0)	
Medical history of chronic illness						
No	42.3 (36.9, 47.8)	47.6 (38.2, 57.3)	0.299	29.1 (24.7, 33.8)	26.9 (22.4, 31.9)	0.535
Yes	57.7 (52.2, 63.1)	52.4 (42.7, 61.8)		70.9 (66.2, 75.3)	73.1 (68.1, 77.6)	
Collective efficacy						
Low	72.0 (66.6, 76.8)	76.2 (67.6, 83.2)	0.375	71.6 (64.2, 78.1)	82.6 (77.0, 87.1)	**0.011**
High	28.0 (23.2, 33.4)	23.8 (16.9, 32.4)		28.4 (22.0, 35.8)	17.4 (12.9, 23.0)	
TOTAL	**73.1 (67.2, 78.3)**	**26.9 (21.7, 32.8)**		**57.3 (53.6, 61.0)**	**42.7 (39.0, 46.4)**	**<0.0001**[a]

Notes: CI – Confidence Interval.

Statistically significant p-values in bold.

[¥] Family history of disease = Chronic non-communicable disease and cancer.

[2] p-values for association of characteristics with Positive Deviance status in males.

[3] p-values for association of characteristics with Positive Deviance status in females.

[a] p-value for difference between prevalence of Positive Deviance in males versus females.

Table 2
Sex-specific and total population prevalence (%) of Positive Deviance status with 95 % confidence intervals (in brackets) within socio-demographic and CVD risk factor categories among 15 + year-old Jamaicans who perceive that they live in vulnerable neighborhoods as estimated for the Jamaica Health and Lifestyle Survey III in 2017.

Characteristics	Male (95 % CI)	p-value[4]	Female (95 % CI)	p-value[5]	Total (95 % CI)	p-value[6]
Age-groups (years)						
15–59	74.5 (68.0, 80.0)	0.363	58.8 (54.8, 62.6)	**0.011**	66.8 (62.7, 70.5)	**0.018**
60+	69.2 (57.1, 79.2)		47.5 (39.8, 55.3)		58.5 (50.8, 65.7)	
Area of residence						
Urban	68.9 (58.7, 77.5)	**0.036**	48.5 (38.5, 58.6)	0.135	61.7 (55.0, 68.0)	**0.033**
Rural	79.4 (74.3, 83.7)		60.6 (55.1, 65.8)		69.9 (65.8, 73.8)	
Education level						
<High school	70.6 (61.7, 78.1)	0.410	62.6 (54.3, 70.2)	0.146	67.2 (60.6, 73.1)	0.576
≥High school	74.8 (67.6, 80.9)		55.9 (51.9, 59.8)		65.2 (60.7, 69.4)	
Number of possessions						
1st tertile (0–5 items)	73.7 (64.1, 81.5)	0.315	59.3 (52.1, 66.2)	0.356	67.1 (60.8, 72.8)	0.716
2nd tertile (6–9 items)	77.1 (71.3, 81.9)		53.4 (47.8, 58.9)		65.4 (61.2, 69.4)	
3rd tertile (10–20 items)	68.6 (55.8, 79.0)		59.5 (51.5, 67.0)		63.8 (55.6, 71.3)	
Employment class						
Employed	77.3 (71.2, 82.5)	0.132	65.9 (61.2, 70.3)	**0.0001**	72.8 (68.6, 76.7)	**<0.0001**
Unemployed	65.0 (52.8, 75.5)		48.5 (42.9, 54.1)		54.5 (48.5, 60.4)	
Student	70.7 (47.7, 86.5)		58.5 (46.0, 70.1)		64.2 (52.6, 74.3)	
Satisfied with life						
No	73.1 (62.3, 81.8)	0.261	58.5 (47.4, 68.8)	0.756	66.1 (58.4, 73.0)	0.684
Yes	78.8 (71.5, 84.6)		56.5 (51.2, 61.7)		67.7 (62.8, 72.4)	
Nutritional status						
Non-obese	76.3 (70.2, 81.5)	**0.018**	65.5 (59.9, 70.7)	**0.0014**	71.9 (66.9, 76.4)	**<0.0001**
Obese	62.9 (50.2, 74.0)		52.1 (46.6, 57.6)		55.5 (50.9, 60.0)	
Underweight/Normal	76.4 (69.8, 82.0)	0.214	61.5 (52.7, 69.6)	0.661	71.3 (65.3, 76.6)	**0.021**
Overweight/Obese	70.2 (60.1, 78.7)		59.2 (54.6, 63.7)		63.5 (58.8, 67.8)	
Alcohol Use						
Never	69.0 (56.4, 79.8)	0.550	57.8 (52.9, 62.5)	0.967	61.1 (56.0, 66.0)	0.086
Former drinker	71.6 (59.7, 81.5)		57.5 (49.5, 65.1)		63.9 (57.2, 70.0)	
Past year drinker	76.5 (65.8, 84.8)		58.6 (45.4, 70.7)		66.4 (56.2, 75.2)	
Current drinker	75.8 (67.7, 82.4)		56.1 (48.6, 63.3)		69.8 (63.5, 75.5)	
Depression						
No	75.4 (69.1, 80.7)	0.063	57.8 (53.6, 61.8)	0.671	67.3 (63.2, 71.2)	**0.034**
Yes	61.4 (45.4, 75.2)		55.6 (46.4, 64.4)		57.6 (48.4, 66.3)	
Family history of disease[¥]						
No	77.8 (70.8, 83.5)	0.278	51.4 (42.0, 60.7)	0.149	67.8 (61.6, 73.4)	0.436
Yes	73.1 (65.9, 79.3)		58.5 (54.7, 62.2)		65.5 (61.4, 69.4)	
Medical history of chronic illness						
No	70.6 (62.5, 77.5)	0.174	57.5 (50.3, 64.4)	0.916	65.6 (60.1, 70.8)	0.985
Yes	76.2 (69.2, 82.1)		57.0 (52.7, 61.3)		65.6 (61.1, 69.8)	
Collective efficacy						
Low	75.9 (70.7, 80.5)	0.286	54.3 (48.4, 60.2)	**0.006**	65.0 (61.1, 68.7)	**0.0004**
High	80.5 (73.2, 86.3)		71.8 (61.2, 80.4)		76.6 (70.8, 81.5)	
TOTAL	**73.7 (67.7, 79.0)**		**57.2 (53.5, 60.8)**		**65.6 (61.6, 69.4)**	**p < 0.001**[b]

Notes: CI – Confidence Interval.
Statistically significant p-values in bold.
[¥] Family history of disease = Chronic non-communicable disease and cancer; PD – Positive Deviance.
[4] p-values for difference in prevalence of Positive Deviance status when categories of characteristics in males are compared.
[5] p-values for difference in prevalence of Positive Deviance status when categories of characteristics in females are compared.
[6] p-values for difference in prevalence of Positive Deviance status when categories of characteristics in males and females combined are compared.
[b] p-value for difference between prevalence of Positive Deviance in males versus females.

Table 3
Test statistics for survey weighted logistic regression models with unadjusted interaction between the effect modifier variables and selected population characteristics, significant at the 20 % significance level, among 15 + year-old Jamaicans who perceived they lived in vulnerable communities, JHLS III 2016–2017.

Effect Modifier/Explanatory variable	Numerator degrees of freedom	Denominator degrees of freedom	F test statistic	p-value[7]	Rank of p-values (smallest to largest)
Sex					
Depression	3	156	51.499	3.43×10^{-23}	1
Family history of disease	4	155	38.485	2.42×10^{-22}	2
Education	4	155	36.884	1.20×10^{-21}	3
Age group					
High collective efficacy	3	156	74.113	7.52×10^{-30}	1
Alcohol use	5	154	41.415	7.32×10^{-27}	2
Area of residence					
Obesity	4	155	52.389	7.46×10^{-28}	1

[7] p-values for goodness of fit F test statistic.

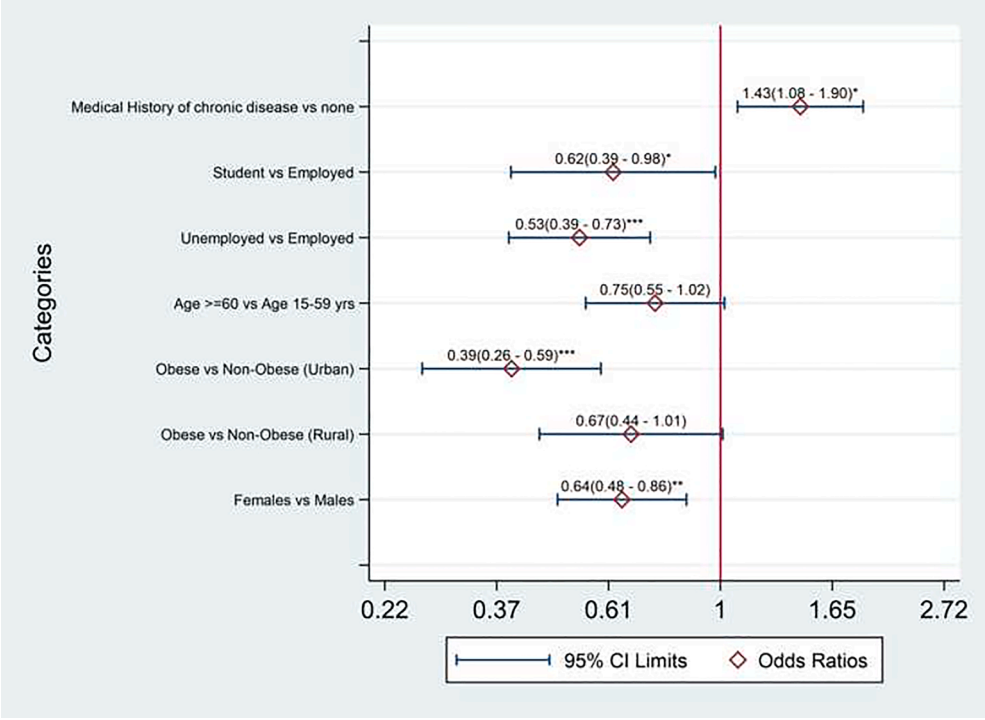

Fig. 1. Odds ratios from multivariable logistic regression model of characteristics associated with Positive Deviance *p < 0.05; **p < 0.01; ***p < 0.0001. P-value for interaction between area of residence and obesity status = 0.076.

that were not statistically significant at the 20 % level yielding the model with the lowest F-adjusted mean residual test statistic equal 20.577 ($p = 2.925\times10^{-22}$). This final best fitting model had the variables sex, age, employment status, personal history of chronic diseases and a term for interaction between urban residence and obesity. The results of the model shown in Fig. 1 below revealed that being female (odds ratio [OR] a = 0.64 (0.48, 0.86); p = 0.003), obese while living in an urban area (ORa = 0.39; 95 % CI = 0.26, 0.59; p < 0.0001), unemployed (ORa = 0.53; 95 % CI = 0.39, 0.73; p < 0.0001), or a student (ORa = 0.62; 95 % CI = 0.39, 0.98); p = 0.041) significantly lowered the odds of PD, while having a personal medical history of at least one chronic disease significantly increased the odds of PD (ORa = 1.43; 95 % CI = 1.08, 1.90; p = 0.014).

4. Discussion

This is the first study to examine factors associated with PD for PA in the Caribbean. Being female, obese while living in an urban area, unemployment, or a being a student were found to be significantly associated with a lower likelihood of engagement of MVPA for persons living in vulnerable neighborhoods; on the other hand, having a personal medical history of at least one chronic disease significantly increased the odds of PD.

Our literature review found no other studies that examined PD for PA as an outcome, therefore our comparisons are confined to studies that have examined PA, and with similar sociodemographic and health-related determinants. For example, our finding of the association of being female with lower levels of PAL in disordered neighbourhoods is similar to what was found from the JHLS II survey (Cunningham-Myrie et al., 2015). The finding of unemployment being negatively associated with less PD is most likely driven by the higher unemployment levels in females, which is also in keeping with past national trends (Wilks et al., 2017). In our study we found being obese while living in an urban area was significantly inversely associated with PD. This was not surprising and may be related to the previous finding in Jamaica of increased adiposity, based on mean waist circumference, among urban residents

living in neighbourhoods with increased crimes/km^2/year (Cunningham-Myrie et al., 2021). Interestingly, although we identified effect modification by age, none of the final models revealed significant associations with PD. It could be that reasons for being a PD do not actually differ by age.

We did not expect students to be less likely to show PD. The fact that the vast majority of students fall within the 15 – 17 age group (usually in grades 11 to 13 in Jamaican secondary schools), may partly explain the reason for this inverse association. In Jamaica, the Health and Family Life Education Curriculum out of the Ministry of Education (Ministry of Education, 2008) addresses PA but mainly targets students in Grades 7 – 9 and supervised PA at school is usually scheduled only for 30 min twice weekly. As such within the school period, where students of this age group spend most of their days, the average student maybe engaged in PALs below that defined as MVPA. Recognizing this, the Jamaican government has intensified its health promotion efforts within high schools to increase PA in this age group, through its 'Jamaica Moves' campaign (Jamaica Moves, n.d.).

It is unclear whether perceived susceptibility to complications of chronic disease and perceived benefits to be accrued from engaging in MVPA may partially explain the finding that having a personal medical history of at least one chronic disease significantly increased the odds of PD. Price et al in a study in Ottawa, Canada found that Health Belief Model constructs explained almost a third of the variance in engagement in MVPA among cancer survivors aged 18 years and older (Price et al., 2021). Future studies could explore quantifying the role of health belief constructs in the association with PD, to ascertain whether they should be targeted in behaviour change interventions to increase PALs, in the Jamaican context.

4.1. Study strengths and limitations

Despite few factors being identified as predictors of PD in this Jamaican sample, our study has identifiable strengths. These include its novelty in being the first to test these associations in Jamaica, a developing country. The study was also conducted using a large nationally representative sample of Jamaicans aged 15 years and older. There are potential limitations to our study. The cross-sectional nature precludes us from discussing causality and examining the many life course factors that may be linked to why one engages in PA. Secondly, the IPAQ has not been validated among Jamaicans. Thirdly, we did not assess whether MVPA was done in non-residential neighborhoods or other locations. Fourthly, most of the survey measures were based on self-report, which may have introduced information bias. Additionally, we defined the neighborhood using primary sampling units constituted of contiguous EDs with a minimum of 18 dwellings. However, neighborhoods are complex entities making it difficult to explore independents effects. Bradley et al have also reported that the PD approach usually starts with qualitative enquiry to identify behaviors of those who have succeeded, and then to actively disseminate those behaviors (Bradley et al., 2009). It is possible that we may have gained additional insights that may have better informed our definition of PD and hypothesized determinants if our enquiry had started using a qualitative approach. Lastly, our study did not explore the role of social connections, financial constraints, features of spaces for exercise and psychosocial motivations, which has been done in other qualitative studies (Stuckey et al., 2011; Harley et al., 2014).

5. Conclusions

This study identified the factors positively and inversely associated with PD for PA in Jamaicans, that is, persons who live in vulnerable neighborhoods yet engage in MVPA. Irrespective of the role that perceived community crime and safety problems, as well as neighborhood disorder may play in PAL, it is important that we identify reasons for PA engagement, including the role of upstream social determinants. Taking a PD approach may be one angle to consider in trying to determine what is working and for whom, so that this may be harnessed in policy, prevention and intervention programming to increase PA. Future studies, both quantitative and qualitative, should be done to further explore how engagement in PA is associated with these psychosocial factors, especially from a gendered perspective and whether other mechanistic pathways may explain PD.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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References

Archer, K.J., Lemeshow, S., 2006. Goodness-of-fit Test for a Logistic Regression Model Fitted using Survey Sample Data. The Stata Journal. 6 (1), 97–105. https://doi.org/10.1177/1536867X0600600106.

American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5®). American Psychiatric Pub; 2013 May 22.

Bauman, A.E., Reis, R.S., Sallis, J.F., Wells, J.C., Loos, R.J., Martin, B.W., 2012. Lancet Physical Activity Series Working Group. Correlates of physical activity: why are some people physically active and others not? Lancet. 380 (9838), 258–271.

Bradley EH, Curry LA, Ramanadhan S, Rowe L, Nembhard IM, Krumholz HM. Research in action: using positive deviance to improve quality of health care. Implement Sci. 2009 Dec;4(1):1-1.

Carlson, J.A., Bracy, N.L., Sallis, J.F., Millstein, R.A., Saelens, B.E., Kerr, J., Conway, T.L., Frank, L.D., Cain, K.L., King, A.C., 2014. Sociodemographic moderators of relations of neighborhood safety to physical activity. Med Sci Sports Exerc. 46 (8), 1554.

Chaparro, M.P., Bilfield, A., Theall, K.P., 2019. Exposure to Neighborhood Crime Is Associated with Lower Levels of Physical Activity and Higher Obesity Risk among Adolescent Girls, but Not Boys. Child Obes 15 (2), 87–92.

Cunningham-Myrie, C.A., Theall, K.P., Younger, N.O., Mabile, E.A., Tulloch-Reid, M.K., Francis, D.K., et al., 2015. Associations between neighborhood effects and physical activity, obesity, and diabetes: The Jamaica Health and Lifestyle Survey 2008. J Clin Epidemiol. 68 (9), 970–978.

Cunningham-Myrie, C.A., Royal-Thomas, T.Y., Bailey, A.E., Gustat, J., Theall, K.P., Harrison, J.E., Reid, M.E., 2019. Use of a public park for physical activity in the Caribbean: evidence from a mixed methods study in Jamaica. BMC Public Health. 19 (1), 894.

Cunningham-Myrie, C., Theall, K.P., Younger-Coleman, N., Greene, L.G., Lyew-Ayee, P., Wilks, R., 2021. Associations of neighborhood physical and crime environments with obesity-related outcomes in Jamaica. PLoS One. 16 (4), e0249619.

Diez Roux, A.V., Mair, C., 2010. Neighborhoods and health. Ann N Y Acad Sci. 1186, 125–145.

Douglas, J.A., Briones, M.D., Bauer, E.Z., Trujillo, M., Lopez, M., Subica, A.M., 2018. Social and environmental determinants of physical activity in urban parks: Testing a neighborhood disorder model. Prev Med. 1 (109), 119–124.

Elo, I.T., Mykyta, L., Margolis, R., Culhane, J.F., 2009. Perceptions of neighborhood disorder: The role of individual and neighborhood characteristics. Soc Sci Q. 90 (5), 1298–1320.

Felker-Kantor EA, Cunningham-Myrie C, Greene LG, Lyew-Ayee P, Atkinson U, Abel W, Clarke P, Anderson SG, Theall KP. Neighborhood crime, disorder and substance use in the Caribbean context: Jamaica National Drug Use Prevalence Survey 2016. PloS One. 2019;14(11).

Foster, B.A., Aquino, C.A., Mejia, S., Turner, B.J., Singhal, A., 2018. Identification and Characterization of Families That Are Positively Deviant for Childhood Obesity in a Latino Population: A Case-Control Study. J Obes. 2018.

Global action plan on physical activity 2018–2030: more active people for a healthier world. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.

Harley, A.E., Rice, J., Walker, R., Strath, S.J., Quintiliani, L.M., Bennett, G.G., 2014. Physically active, low-income African American women: an exploration of activity maintenance in the context of sociodemographic factors associated with inactivity. Women Health. 54 (4), 354–372.

Harriott, A., Jones, M., 2016. Crime and Violence in Jamaica. Inter-American Development Bank (IDB).

Hosmer Jr, D.W., Lemeshow, S., 2000. Applied logistic regression. John Wiley & Sons.

International Physical Activity Questionnaire, IPAQ scoring protocol. [Cited 2021 Jan 24]. Available from: https://sites.google.com/site/theipaq/scoring-protocol.

IPAQ Research Committee, 2005. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ). – Short and Long Forms. 1–15.

'Jamaica Moves' to be Introduced in High Schools [Internet]. Jamaica Information Service. [cited 2022 Jul 3]. Available from: https://jis.gov.jm/jamaica-moves-to-be-introduced-in-high-schools/.

King, K.E., Morenoff, J.D., House, J.S., 2011. Neighborhood context and social disparities in cumulative biological risk factors. Psychosom Med. 73 (7), 572–579.

Kinsey AW, Segar ML, Barr-Anderson DJ, Whitt-Glover MC, Affuso O. Positive Outliers Among African American Women and the Factors Associated with Long-Term Physical Activity Maintenance. J Racial Ethn Health Disparities. 2019 Jun 15;6(3): 603-17.

Kraschnewski JL, Stuckey HL, Rovniak LS, Lehman EB, Reddy M, Poger JM, Kephart DK, Coups EJ, Sciamanna CN. Efficacy of a weight-loss website based on positive deviance: a randomized trial. Am J Prev Med. 2011 Dec 1;41(6):610-4.

Mackintosh UA, Marsh DR, Schroeder DG. Sustained positive deviant child care practices and their effects on child growth in Viet Nam. Food Nutr Bull. 2002;23(4_suppl_1): 16-25.

Marsh DR, Schroeder DG. The positive deviance approach to improve health outcomes: experience and evidence from the field—Preface. Food Nutr Bull. 2002 Dec;23(4_suppl2):3-6.

Ministry of Education, Jamaica. Health & Family Life Education Curriculum. Refined Scope and Sequence Grades 7-9 2nd ed2008.

Oyeyemi, A.L., Adegoke, B.O., Oyeyemi, A.Y., Sallis, J.F., 2011. Perceived environmental correlates of physical activity and walking in African young adults. Am J Health Promot 25, e10–e19.

Oyeyemi, A.L., Adegoke, B.O., Sallis, J.F., Oyeyemi, A.Y., De Bourdeaudhuij, I., 2012. Perceived crime and traffic safety is related to physical activity among adults in Nigeria. BMC Public Health. 12 (1), 294.

Oyeyemi, A.L., Kolo, S.M., Oyeyemi, A.Y., Omotara, B.A., 2019. Neighborhood environmental factors are related to health-enhancing physical activity and walking among community dwelling older adults in Nigeria. Physiother Theory Pract. 35 (3), 288–297.

Parra, D.C., Hoehner, C.M., Hallal, P.C., Ribeiro, I.C., Reis, R., Brownson, R.C., et al., 2011. Perceived environmental correlates of physical activity for leisure and transportation in Curitiba. Brazil. Prev Med. 52, 234–238.

Price, J., Barrett-Bernstein, M., Wurz, A., Karvinen, K.H., Brunet, J., 2021. Health beliefs and engagement in moderate-to-vigorous-intensity physical activity among cancer survivors: a cross-sectional study. Supportive Care in Cancer. 29 (1), 477–484.

Rees-Punia, E., Hathaway, E.D., Gay, J.L., 2018. Crime, perceived safety, and physical activity: A meta-analysis. Prev Med. 1 (111), 307–313.

Richardson, A.S., Troxel, W.M., Ghosh-Dastidar, M.B., Beckman, R., Hunter, G.P., DeSantis, A.S., Colabianchi, N., Dubowitz, T., 2017. One size doesn't fit all: cross-sectional associations between neighborhood walkability, crime and physical activity depends on age and sex of residents. BMC Public Health. 17 (1), 97.

Sallis JF, Owen N, Fisher E. Ecological models of health behavior. In: Glanz K, Rimer BK. and K. Viswanath (EDs). Health Behavior and Health Education: Theory, Research, And Practice 4th ed. Jossey-Bass, San Francisco, pp 465-486.

Sampson, R.J., Raudenbush, S.W., Earls, F., 1997. Neighborhoods and violent crime: A multilevel study of collective efficacy. Science. 277 (5328), 918–924.

Schulz, A.J., Mentz, G., Lachance, L., et al., 2013. Do observed or perceived characteristics of the neighborhood environment mediate associations between neighborhood poverty and cumulative biological risk? Health Place. 24, 147–156.

Stafford M, Cummins S, Macintyre S, Ellaway A, Marmot M. Gender differences in the associations between health and neighbourhood environment. Soc Sci Med. 2005 Apr 1;60(8):1681-92.

Stuckey, H.L., Boan, J., Kraschnewski, J.L., Miller-Day, M., Lehman, E.B., Sciamanna, C. N., 2011. Using positive deviance for determining successful weight-control practices. Qual Health Res. 21 (4), 563–579.

Timmerman GM. Addressing barriers to health promotion in underserved women. Fam Community Health. 2007 Jan 1;30:S34-42.

Troped, P.J., Tamura, K., Whitcomb, H.A., Laden, F., 2011. Perceived built environment and physical activity in US women by sprawl and region. Am J Prev Med. 41 (5), 473–479.

Van Dyck, D., Cerin, E., Conway, T.L., De Bourdeaudhuij, I., Owen, N., Kerr, J., Cardon, G., Frank, L.D., Saelens, B.E., Sallis, J.F., 2012. Perceived neighborhood environmental attributes associated with adults' transport-related walking and cycling: Findings from the USA, Australia and Belgium. Int J Behav Nutr Phys Act. 9 (1), 70.

Weber Corseuil, M., Hallal, P.C., Xavier Corseuil, H., 2012. Jayce Ceola Schneider I, d'Orsi E. Safety from crime and physical activity among older adults: a population-based study in Brazil. J Environ Public Health. 2012.

Wilks R, Younger-Coleman, S. McFarlane, M. Tulloch-Reid, A. Grant, K. Webster-Kerr, et al. Jamaica Health and Lifestyle Survey III 2017, Technical Report (in press).

Wilks, R., Younger, N., Tulloch-Reid, M., McFarlane, S., Francis, D., 2008. Jamaica Health and Lifestyle Survey 2007–8. Tropical Medicine Research Institute, University of the West Indies, Mona, Kingston.