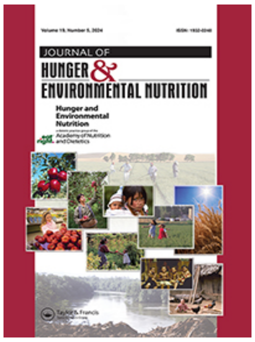

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Contextualising individual, household and community level factors associated with sugar-sweetened beverage intake and screen time in Soweto, South Africa

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ABSTRACT

This study examined the relationship between individual, household, and community-level factors with obesity-related health behaviors. Households (n = 6110) were enumerated, and participants (>18 years) reported their screen time and how many sugar-sweetened beverages they consumed per day. Individuals from food insecure and higher SES households were more likely to report higher sugar-sweetened beverage consumption. Screen time was negatively associated with age ($p < .01$), and being female was associated with 35 minutes more screen time per day ($p < .01$). Community and household factors were independent drivers of behavior that need to be incorporated into individual level interventions, or considered in analyses.

KEYWORDS

Health behaviors; South Africa; sugar-sweetened beverages; obesity risk; screen time

Introduction

In the face of a rising global obesity epidemic, in which South African women have among the highest prevalence of obesity in the world, observational studies have shown that context matters in determining obesogenic environments, and needs to be considered in designing more effective public health interventions.[1] Context can be defined as the surroundings, circumstances, environment, background, or settings that determine, specify, or clarify health behaviors. While considerable advancements have been made in contextualizing individual-level associations with lifestyle behaviors related to obesity - such as sugar-sweetened beverage (SSB) intake, diet, physical inactivity, and sedentary behavior (such as screen time) - many public health interventions that target only

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individual-level drivers have been unsuccessful in achieving long-term behavior change.[2] It is likely that when considering individual-level interventions, structural issues in the household and the community that may be impeding behavior change are overlooked.[3,4] A recent systematic review of the relationships between environment and adult weight status in high-income countries showed that urban sprawl and land use mix were consistently associated with increased adult weight.[1] Since environments and contextual drivers of behavior are likely to be very different in lower-income countries, associations from high-income countries may not be relevant to other settings. Thus, the local environments should be properly contextualized, along with individual-level drivers of behavior change.

In South Africa, to our knowledge, there have been no multilevel effect studies examining the interplay between individual factors and contextual factors in relation to obesity-risk behaviors. However, recent qualitative work conducted with young women in Soweto highlighted that maintaining a healthy lifestyle is difficult due to environmental factors such as household income, community safety and engagement, lack of recreational facilities, and lack of investment from policy makers.[5,6] Therefore, it is likely that these contextual factors are moderating health behaviors and therefore health outcomes. The Healthy Lifestyle Trajectories Initiative (HeLTI) is a multi-country study supported by the World Health Organization, with an aim to optimize health in young women of reproductive age. Within urban Soweto, a densely populated, low-income peri-urban township in South Africa, the formative work for HeLTI involved understanding the contextual drivers of health behavior particularly those related to community, household, and individual level correlates of obesity.

Two lifestyle behaviors have been identified as useful indicators of dietary and sedentary behaviors linked to obesity: SSB consumption and screen time. The links between SSB consumption and obesity are well established. There is evidence from low- and high-income countries that SSB consumption is prevalent and increasing, and that SSB consumption is associated with obesity and with type-2 diabetes; particularly in low-to-middle-income countries.[7] Screen time, as an independent behavior and as an indicator of sedentary behavior, has also been consistently associated with obesity.[8] Additionally, SSBs are often advertised using screen media, constituting up to 10% of television advertisements in South Africa in 2011.[9] Both of these behaviors have been shown to be prevalent and increasing in South Africa and in other developing countries,[7,10,11] and are able to be assessed using large-scale survey instruments. Thus, this study enumerated eight randomly identified community areas in Soweto with the aim to examine the relationship between individual, household, and community-level sample characteristics and individual SSB consumption and screen time in adults from Soweto, South Africa.

Materials and Methods

Study Design

This study was an observational, cross-sectional survey. Household surveys were conducted in randomly selected communities across the urban township of Soweto. Soweto forms part of the greater Johannesburg area. It has an area of approximately 200 km^2 and a population of around 1.3 million people with a density of 6357 people per square kilometer (Census, 2011). An online search was performed using the Google search engine to locate the information of all churches in Soweto. Churches were used as geographical landmarks to estimate community centers in Soweto, given the large number of community churches throughout Soweto. Using street address information, geolocations of each church structure were obtained, and each church was visited by fieldworkers and verified. The latitude and longitude of the 104 churches were then classified using k-means clustering in order to demarcate thirty community areas with a 1 km^2 radius each. The algorithm aims to divide M (104) points with N (2) dimensions into K (30) communities in such a way as to minimize the sum of squares within each cluster.[12] Figure 1 illustrates how the 30 derived centroids overlay on the map of churches in Soweto. For the purposes of this study, 8 communities were randomly selected using Excel random function, and were extensively enumerated. These community areas were labeled numerically. Prior to initiating enumeration of these communities, engagement with each community was conducted via attendance and presentation at ward counselor meetings, individual meetings with ward counselors, radio and print interviews and awareness campaigns, and informal discussions with community leaders.

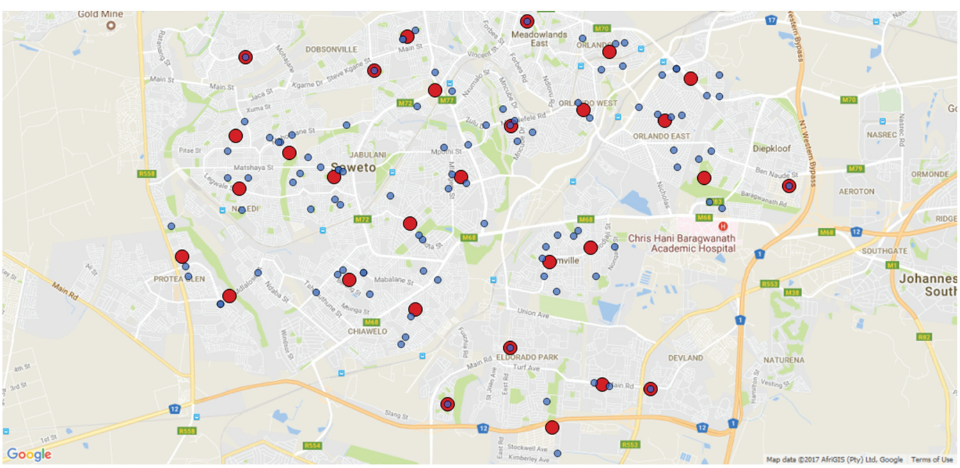

Figure 1. Red points indicate community centers and blue points indicate churches in Soweto.

Participant Selection

Participants were approached at their home if they lived within the 8 communities identified, and were asked to participate. One participant from each eligible home was included if they were ≥18 years old and were a regular member of the household (spent most nights in the home over the past three months). If the person approached did not fit the inclusion criteria, alternative members of the household who did meet these criteria were approached. All participants provided written informed consent, and were free to stop the survey at any time. Approval for the study was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (M170947). The entire process of providing informed consent and completing the survey took approximately 30 minutes.

A team of trained fieldworkers working in pairs (one male and one female) recruited participants and administered the survey. Fieldworkers collected data between 8:00 and 17.30 during the week, as well as, between 8:00 and 12:00 on Saturdays in order to maximize participant availability at the home. Upon approaching a household, the GPS coordinates were captured using Google Maps, and an attempt was made to make contact with a member of the household. When a homestead was encountered (multiple households on the piece of land), one interview was conducted per household within that homestead. Each household had a unique ID number. If household members were not willing to participate, this refusal was noted and fieldworkers moved on to the next household on the street. If there was no one available at the household, one follow-up visit was conducted (either at a pre-specified time or on a Saturday). If, at the return visit, no one was available at the household for a second time, this household was recorded as unavailable. Using this approach, the fieldwork team attempted to enumerate every household within the 8 communities. Data collection took place between November 2017 and June 2019. All data was captured directly onto RedCap[13] using tablet devices.

Demographic Data

The questionnaire (using tools from the South African Demographic and Health Survey unless otherwise specified[14]) asked participants to list the number of people living in their household, as well as the age, sex (check box to indicate "Male" or "Female"), relationship to participant, and highest level of education for each of these members of the household. Thereafter they were asked to describe the structure of their household from a number of options, and these were categorized as: a house of brick/concrete block structure on a separate stand or yard or on a farm; house/flat/room on a homestead; an informal dwelling; or other. The number of rooms available for sleeping was reported in order to calculate household density. Participants were also asked to rate their perceived safety of their immediate neighborhood (within 20-minute walk from home) using a 5-point Likert scale specific to this study.

Participants were asked about their main source of drinking water (categorized as piped in the home, piped outside the home, other) and to describe the type of toilet facilities available (categorized as flush toiled or not flushed toilet, and shared with other households or private). Two questions estimated food security by asking participants whether anyone in the home went hungry in the past 12 months because there was not enough food to eat, as well as whether this had happened within the past 30 days, and in the past 5 days. This data was reported as presence of any food insecurity in the last year, month, and past 5 days (yes or no).

Socioeconomic status (SES) was estimated by asking participants to list whether they had access to a number of assets within the home; such as electricity, fridge, stove, vacuum cleaner, washing machine, M-Net/DSTV (paid Satellite television service), DVD player, motorcar, television, telephone (landline), cell phone, computer, or laptop or tablet, and internet access.

Outcome Measures

Participants were asked to report on the amount of time they spent watching TV or in front of a screen during the past week and during the past weekend (as average minutes per day – taken from the General Physical Activity Questionnaire (GPAQ).[15]) Participants were also asked to describe how many SSBs (standard 330 ml can of soda, flavored water, fruit juice, other fizzy drinks) they consumed on average per day and this was categorized as: none, 1–3 per day, 4–6 per day, or >6 per day.

Statistical Analysis

All data were analyzed using Stata V13 for Mac. In order to characterize the participants – household, individual, and community level sociodemographic and health-related data were summarized. In order to determine potential differences between community areas, participant data were stratified by the eight community areas and described. All data were reported using medians (range) or n (%).

Thereafter, associations between sociodemographic data and individual SSB consumption and screen time were assessed using a series of multilevel heirachical linear regression models with either SSB consumption or screen time as the outcomes. For both outcomes; model 1 included individual-level variables (age, sex, education); model 2 included household-level variables (household composition, household structure, SES, food insecurity, water access, toilet access); model 3 included community-level variables (perceived neighborhood safety and community area); and model 4 included all individual, household, and community-level predictors together. Residual plots for the final models were examined to determine appropriateness of the model fit.

Results

Participant Individual, Household, and Community-Level Descriptive Statistics

A total of 6088 participants who completed the questionnaires provided at least some demographic information (Table 1). Respondents' age ranged from 18 to 88 years old, and the majority of participants reported being female. Just over half (57%) of the survey respondents had completed high school (i.e.: matric) or further education. Most respondents felt safe during the day (82%), but unsafe at night (57%) in their neighborhood. Participants reported spending on average 240 minutes per day of screen time during the week, and 180 minutes per day on the weekend. Most participants (58%) reported drinking 1–3 SSBs per day, and only 4% reported drinking no SSBs on an average day.

On average, houses surveyed comprised of four occupants. However, household density (number of people living in the home divided by the rooms to sleep in) ranged from <1 person per room to 15 people per room, with an average of 2 people per room. The average sum of household assets (score out of 13 assets in the home) was 8. Most households had electricity, a fridge, a stove, a TV, and a cell phone; but far fewer had a car, a landline, a washing machine or a vacuum cleaner. Nearly half (48%) of households shared a toilet with other households, but most (98%) had access to piped water (either in their home or in their yard). Most (76%) identified their home as a house of brick/concrete; while 14% identified their home as an informal dwelling or shack in a backyard. Food insecurity was present in 24% of households, and was not different according to household structure.

From the 6110 households surveyed, data on 28502 individuals living in those homes were collected. The age range of people living in these homes was 0–111 years, with a median of 26 years. There were more females (58%) than males, and 43% of those over the age of 18 had completed matric, while 8% had an undergraduate education and 1% had a postgraduate education. Of those <18 years old, 83% were in school.

In the eight community areas surveyed, the percentage of people over the age of 18 who had completed matric or further education was lowest in area 2 (45%) and area 6 (48%). Household density was similar across community areas, as was the sum of household assets; however, perceived safety varied, with more people reporting feeling unsafe during the day in area 2 (23%) compared to the other clusters (15% to 20%). Area 1 and area 5 had the highest perceived daytime safety. These trends were similar for perceived nighttime

Table 1. Participant characteristics.

Variable	N	Median or n(%)	Range
Individual level			
Age (years)	6088	29	18–88
Sex (female)	6087	4524(74)	
Education	6083		
In school/completed primary school		2409(40)	
Completed Matric or higher		3482(57)	
Other		114(2)	
None		78(1)	
TV time (min/day during week)	5967	240	0–1440
TV time (min/day during weekend)	5965	180	0–1440
Sugar sweetened beverage use	5966		
None		211(4)	
1–3 per day		3489(58)	
4–6 per day		1341(22)	
>6 per day		925(16)	
Household level			
Number of people living in the home	6110	4	1–24
Household density (people/room)	5970	2	<1–15
Sum of assets (score/13)	5887	8	1–13
Electricity		5940 (99)	
Fridge		5495 (92)	
Stove		5896 (99)	
Vacuum cleaner		642 (11)	
Washing machine		3062 (51)	
Satellite/DSTV/Mnet		3453 (58)	
DVD player		3513 (59)	
Car		1913 (32)	
Internet		4618 (77)	
TV		5592 (94)	
Landline phone		474 (8)	
Cellphone		5845 (98)	
Computer		2513 (42)	
Household structure	5922		
House		4524 (76)	
Flat/house on a homestead		403 (7)	
Informal		817 (14)	
Other		178 (3)	
Water usage	5973		
Piped in house		3292 (55)	
Piped in yard		2584 (43)	
Communal		69 (1)	
Other		28 (1)	
Toilet type	5972		
Flush		5818 (97)	
Other		154 (3)	
Toilet shared with other household (yes)	5973	2848 (48)	
Hunger (yes)	5966	1420 (24)	
Hunger in last month (yes)		683 (49)	
Hunger in last 5 days (yes)		260 (39)	
Community Level			
Safety during the day	5973		
Unsafe or very unsafe		1048 (18)	
Safe or very safe		4925 (82)	
Safety at night	5972		
Unsafe or very unsafe		3416 (57)	

safety. Area 2 had the fewest people reporting living in informal settlements (4%) and the most living in freestanding houses (87%), while area 8 showed the opposite trend with 26% in informal settlements and 62% in freestanding houses. People living in areas 3 and 8 most often reported sharing a toilet with other households (64% and 68% respectively) compared to <50% in other clusters, and only 27% sharing a toilet in area 5. The prevalence of food insecurity was similar across clusters.

Regression Model Statistics

A multilevel hierarchical linear regression model was used to determine associations between individual, household, and community level socio-demographic data and SSB consumption and screen time. Table 2 shows the results from the regression analyses, including the R^2 values for each model (which were highest in the final models in both cases). While the adjusted R^2 for the final models are low (0.02 for the SSB outcome and 0.07 for the screen time outcome), this is likely due to the large number of other factors that could be contributing to the variation which were not measured in this study (such as other lifestyle factors, employment type, mental health, and other contextual factors), however the presence of statistical significance in the models (based on p-values, 95% CIs and Beta-coefficients can be interpreted as trends in relationships between the independent and dependant variables in the models.

In combined models, there were no individual-level factors associated with SSB consumption. However, individuals living in food insecure households, or households with higher SES were more likely to report higher SSB consumption. Compared to living in the main household on a homestead, those living in other types of housing, such as informal housing or apartments, were likely to report lower levels of SSB consumption, as were individuals who reported sharing a toilet with other households. Furthermore, at community level, higher perceived safety at night was associated with lower SSB consumption. There were also differences in consumption according to the community area within which individuals resided.

Higher screen time was negatively associated with age ($p < .01$), and being female was associated with spending up to 35 minutes more per day using screens than being male ($p < .01$). Higher educational attainment was also associated with higher screen time. Individuals living in households with higher SES, as well as those with higher household density were more likely to report higher screen time. Living in informal housing was associated with lower screen time, yet sharing a toilet with other households was associated with higher screen time. From a community levels, higher daytime safety, but lower perceived night time safety were associated with higher screen time – feeling safe at night was associated with one hour less screen time per day; however feeling safe during the day was associated with over an hour more screen time per day. There were also differences in screen time according to

Table 2. Results from the multiple linear regressions for sugar sweetened beverage use, and screen time outcome variables.

		Sugar sweetened beverage consumption ß coefficient				Screen time ß coefficient			
		Model 1 Individual	Model 2 Household	Model 3 Community	Model 4 Combined	Model 1 Individual	Model 2 Household	Model 3 Community	Model 4 Combined
Individual level variables	Age (years)	−0.003			−0.007	−2.072***			−2.291***
	Sex (female)	−0.042			0.053	35.050***			35.310***
	Education level								
	In school/completed primary school	base							
	Matric or higher	0.102			0.014	43.460***			22.470***
	Other	−0.054			−0.101	60.570***			48.270**
	None	−0.264			−0.425	−7.556			14.710
Household level variables	Food insecurity (yes)		0.313**		0.263**		2.870		9.663
	SES (n/13)		0.099***		0.080***		19.680***		16.160***
	Household density (rooms/ person)		−0.057		−0.062		10.850***		6.767***
	Household structure								
	House	Base							
	Flat/house on homestead		−0.495**		−0.465**		32.490**		18.040
	Informal		−0.348**		−0.337		−13.430		−19.960**
	Other		−0.617		−0.712**		1.840		−9.416
	Water use								
	Regional	Base							
	Other		−0.330		−0.497		−23.970		−10.760
	Toilet type								
	Flush	Base							
	Other		0.156		0.196		−11.360		−22.190
	Shared toilet (yes)		0.297**		0.273**		26.570***		15.030**
	Safety during the day								

(*Continued*)

Table 2. (Continued).

		Sugar sweetened beverage consumption ß coefficient				Screen time ß coefficient			
		Model 1 Individual	Model 2 Household	Model 3 Community	Model 4 Combined	Model 1 Individual	Model 2 Household	Model 3 Community	Model 4 Combined
Community level variables	*Very unsafe*	Base							
	Unsafe			0.390	0.377			2.908	31.040
	Safe			0.185	0.170			46.250**	60.670***
	Very safe			0.218	0.177			75.140***	79.090***
				Safety at night					
	Very unsafe	Base							
	Unsafe			−0.490***	−0.503***			−46.260***	−48.540***
	Safe			−0.461**	−0.469**			−57.220***	−58.180***
	Very safe			0.507	0.406			−72.230***	−62.440***
				Community area					
	1	Base							
	2			−0.0254	−0.082			18.830	12.630
	3			−0.289	−0.331			−0.360	−1.822
	4			−0.079	−0.111			4.959	6.797
	5			−0.409**	−0.474**			−6.208	−22.880
	6			−0.205	−0.302			−15.780	−30.170**
	7			−0.451	−0.461			−2.291	−16.680
	8			−0.572**	−0.600**			−31.160**	−43.770***
	Observations	5,940	5,786	5,962	5,759	5,940	5,786	5,963	5,758
	R-squared	0.000	0.006	0.007	0.013	0.041	0.034	0.010	0.075
	*** p < .01, ** p < .05								

the community area within which individuals resided, whereby living in areas 6 or 8 were associated with 30 and 44 minutes more screen time per day respectively.

Discussion

This study aimed to contextualize the environment in Soweto and determine associations with individual level obesity-risk factors. The need to properly understand contextual drivers of lifestyle behaviors has been consistently highlighted in public health research, showing that interventions (such as HeLTI) need to be designed considering how the environment may affect responsiveness. Often, settings such as Soweto are considered relatively homogenous, and described as one population. However, this study shows that there is variation in associations with obesity-risk factors according to community area.

SSB consumption is one indicator of dietary behavior, and is related to obesity risk, type-2 diabetes, and metabolic syndrome.[7,10,16,17] SSB consumption was high in the majority of this sample, with the majority of participants reporting 1–3 sugar sweetened beverages per day. The WHO recommends that free sugar intake is restricted to less than 10% of total energy intake (preferably less than 5%),[18] which equates to about 6 teaspoons of sugar per day. One average small SSB (330 ml) contains about 8–9 teaspoons of sugar. Therefore, even before consumption of any free sugar in foods, the large majority (96%) of this population were far exceeding these guidelines from beverages alone. In India, a nationally representative survey showed SSB consumption equated to 12% of total beverage consumption, equating to between 40 and 50 kilocalories per day.[19] In 2010, global average SSB consumption was 0.58 servings per day, and consumption was highest upper- and lower- middle-income countries.[20] A study conducted in Soweto investigating perceptions of SSBs and the recently implemented sugar tax showed that participants (aged 18–55 years, 51% female) reported constant and regular consumption of SSBs amounting to at least 1–2 bottles (330 ml), usually of Coca-Cola, per day.[21] Participants reported that drinking these beverages was a “habit,” and that they drank them from “morning to evening,” and also that regular advertisements for these beverages and easy accessibility on every street corner influenced consumption.[21] The density of SSB advertisements and availability from street vendors has been objectively verified using GPS mapping of Soweto.[22]

The present study found that there were no individual level correlates of SSB consumption, while there were various household and community-level drivers related to socioeconomic status and neighborhood. This indicates that in this setting, the drivers of SSB consumption, and possibly other diet-related behaviors, were largely driven by environmental factors. Thus, interventions aiming to change these behaviors which focus solely on individual-level risk factors are likely to be unsuccessful, and perhaps interventions should target specific geographical areas or researchers should try to understand what it is about specific communities or environmental factors that drive this behavior. It is important to note that at the time of this study being conducted, a SSB tax had recently been implemented in South Africa legislated through the Rates and Monetary Amounts and Amendment of Revenue Laws Act, 2017 – Act No. 14 of 2017, which took effect on 1 April 2018. This tax could have had short-term effects on how SSBs were being consumed as most of the data were collected after this tax was implemented, and could have affected different communities to varying extents due to advertising, awareness, and policy implementation. However, qualitative work in this community has recently shown that the sugar tax would be unlikely to reduce SSB consumption.[21] Data from the present study show that SSB consumption did not change during the study period, indicating that the tax laws did not impact behavior in this period of time (data not shown).

In relation to screen time, relationships were evident with individual, household, and community-level factors. Similar to previous studies on sedentary behavior in low- and middle-income countries, screen time was shown to be increased with higher education level attained.[23,24] However, we also found screen time to be higher if participants were female and younger, which was not shown in previous studies. Internationally, correlations between age and gender and sedentary time are mixed.[25] There has been limited work quantifying screen time in low- and middle-income countries,[23] or in South Africa, and comparisons with high-income countries may not be appropriate. In this study, community and household factors were also independently associated with screen time. Participants from households that had higher SES, or more formal household structures reported higher screen time. Furthermore, the community area within which participants resided was independently associated with screen time. Interestingly, while safety was associated with screen time, the relationship was dependant on time of day. It is plausible that individuals who reported nighttime safety in their neighborhood were more likely to spend time outside and socializing than inside watching TV at night. Again, these findings indicate that there are a multitude of factors that need to be considered when attempting to change health behaviors such as screen time. For example, for individuals in crowded households (probably with one TV in a shared living space), interventions to reduce screen time are unlikely to be effective unless the entire household is engaged and committed to the behavior change. The disparities in screen time were large, in that the community area within which participants lived was associated with up to nearly 50 minutes difference in screen time per day, while participants sex was associated with a 35 minute per day difference in screen time. Given the evidence for the relationship between screen time (often used as a proxy for sedentary time) and obesity,[25,26] and the international recommendations that exist for limiting sedentary time through reducing screen time for children[27] and adults[28] – such large discrepancies indicate the importance of understanding environmental drivers of this behavior and targeting communities and individuals more effectively. Participants in the current study reported on average 4 hours of screen time per day during the week, and 3 hours on weekends. This, in combination with the potential of additional sedentary time occurring throughout the day (an average of 6 hours per day has been shown in Soweto populations previously,[29]) indicates an excessive amount of sedentary time in this community. More than 7 hours per day of self-reported sedentary time has been found to be associated with all-cause mortality.[28]

This study showed that communities in Soweto were distinct in terms of education level, perceived neighborhood safety, housing structure, and toilet access; yet were similar in terms of prevalence of food insecurity, access to household assets, and household density. This information is important for the design and implementation of obesity management or public health prevention interventions. For example, level of education and perceived neighborhood safety are known to be related to physical activity and inactivity[4] in that higher levels of education are often related to higher sedentary (and screen) time, and to lower physical activity in low- and middle-income countries,[23,24] while the converse is true in high-income countries.[25,26] Furthermore, perceived lack of safety in the neighborhood environment is related to lower levels of physical activity in both empirical and qualitative studies.[4,30] In fact, recent qualitative work conducted in this population showed that young women were afraid to exercise in their neighborhood due to fear of assault, rape, and other violent crimes.[5] The disparity in these environments by community area indicates that these factors need to be measured and accounted for in observational studies, and that interventions need to be designed taking into account the structure of the community area within which participants reside, and linking with local services. Conversely, it is important to be aware of the fact that household factors such as food insecurity, access to household assets and household density were relatively homogenous across community areas. These factors are also likely to affect obesity-related behaviors,[4,30] yet it may be that these variables can be considered relatively stable across a setting such as Soweto.

This study is limited by the self-report nature of the survey, which is prone to bias particularly in relation to questions of a sensitive nature or those which may be perceived as desirable. The question about perceived safety measured using a Likert scale is not a validated tool, but provided an indication of how safe participants felt in their neighborhood. Furthermore, while SSB consumption and screen time are feasible for use in large-scale survey studies, they are merely indicators of dietary and sedentary behaviors respectively, and the impact of these behaviors on obesity is likely modified by other behavioral and contextual factors not measured in this study (as indicated by the low adjusted R^2 for the final models). This large-scale survey assessed number of SSBs consumed per day (using an average 330 ml can as an example of one unit), yet did not quantify volumes or types of SSBs consumed in detailed, providing an estimate of SSB consumption behavior rather than an accurate estimate of volume of sugar consumed (which was beyond the scope of this paper). The implementation of the South African sugar sweetened beverage tax at the beginning of the data collection period may have influenced health behaviors around SSB consumption, yet evidence on SSB consumption before and after the tax laws indicate that this was unlikely; and in this study there were no differences in reported SSB consumption over time. While cognizant of these limitations, this study has managed to capture extensive sociodemographic data in a large and varied sample in Soweto, thus providing valuable information for studies, and policy implementation in this setting. The findings from this study indicate that HeLTI, an individual-level intervention study, needs to be cognizant of the impact that the environment in Soweto in general, and in different communities in Soweto may have on the responsiveness of individuals to the intervention independently of individual level drivers. It will be important for the HeLTI intervention to capture extensive information on sociodemographics, household environment, and on the community environment to assess if these factors influence the intervention delivery and outcomes. It may be that certain community areas respond differently to the intervention due to different drivers of behavior that exist, and as such HeLTI will account for participant's neighborhoods, and may need to conduct further neighborhood mapping activities to quantify these differences more extensively.

These findings highlight the importance of properly contextualizing the environment within which health behavior research is conducted, and the relationships with the health behaviors of interest. Environmental factors are strong and independent drivers that need to be either incorporated into intervention design and delivery, or measured and considered in analyses. Additionally, these findings provide valuable information for policy makers regarding contextual factors driving unhealthy behaviors, and the factors likely to impact the effectiveness of initiatives such as SSB taxation. Further work needs to be conducted to properly investigate how best to incorporate these types of findings into intervention design and policy implementation.

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Author Contribution

AP conceptualised the study, managed data collection, analysed the data, and wrote and approved the manuscript. LJW reviewed and approved the manuscript, CED reviewed and approved the manuscript, SL helped conceptualise the HeLTI intervention study and formative work, and reviewed and approved the manuscript, SAN conceptualised the study, acquired the funding, and reviewed and approved the manuscript.

Ethics And Consent

All participants provided written informed consent, and were free to stop the survey at any time. Approval for the study was obtained from the University of the Witwatersrand (M170947) and in accordance with the Helsinki Declaration of 1975, as revised in 2008.

Disclosure Statement

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