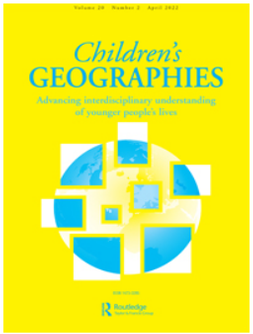

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The relationship between children's third-place play, parental neighbourhood perceptions, and children's physical activity and sedentary behaviour

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ABSTRACT

This study takes a child-centred approach to examine the relationship between children's third-place play, parents' perceptions of their neighbourhood environment, and time spent by children in physical activity and sedentary behaviour during weekday out-of-school hours. A total of 1102 children aged 8–13 years from 19 schools across Auckland, New Zealand took part in a public participation geographic information systems (PPGIS) survey utilising closed- and open-ended questions and child mapping of destinations. The results suggested that playing in green places near home were associated with more time spent in light physical activity and less sedentary behaviour. Children who played in street places near home (e.g. driveways, footpath, carpark) spent more time in moderate to vigorous physical activity. Although parental perceptions of their neighbourhood environment were not directly associated with children's time spent in physical activity, children with parents who perceived their neighbourhood as more connected were more likely to engage in third-place play.

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Built environment; play spaces; third places; physical activity; neighbourhood perceptions; child-centred methods

Introduction

Physical activity (PA) is an essential component of children's healthy development and wellbeing. Studies have shown PA to be favourably associated with physical, psychological, social, and cognitive health indicators in school-aged children and youth (Bull et al. 2020; Janssen and LeBlanc 2010; Poitras et al. 2016). In particular, moderate-to-vigorous physical activity (MVPA) has attracted much attention, with studies consistently indicating its importance for preventing disease and promoting health (Bull et al. 2020; Janssen and LeBlanc 2010; Poitras et al. 2016). International activity guidelines recommend that children and youth accrue an average of 60 min MVPA daily (Bull et al. 2020; Ministry of Health 2017; Tremblay et al. 2016), which can be achieved via a range of activities in a variety of settings (Ridley, Ainsworth, and Olds 2008; Ridley, Olds, and Hill 2006; Smith, Cui, et al. 2021). For children, active play contributes to the accumulation of PA (Egli, Mackay, et al. 2020).

In addition to the acknowledged health benefits of MVPA, all intensities of PA, including light-intensity physical activity (LPA), are recognised as important for disease prevention (Carson et al. 2013). A recent systematic review found positive relationships between PA across a range of

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intensities (i.e. LPA, moderate physical activity (MPA), MVPA, and vigorous physical activity (VPA)) and health indicators in school-aged children and youth (Poitras et al. 2016). The review found that higher intensities of PA (i.e. MVPA and VPA) were more frequently examined, with more consistent associations and larger effect sizes reported than for lower intensity PA (i.e. LPA and MPA). Nevertheless, the positive relationships found between PA of different intensities and health indicators suggest that all intensities of PA are important and that lower intensity PA (e.g. LPA) should also be considered as a health promotion strategy for children and youth.

Over the past decade, sedentary behaviour (SB) has become a growing public health concern and subject of research interest (Tremblay et al. 2011), especially since it has been identified as a health risk factor independent of physical activity (Carson et al. 2016; Mitchell and Byun 2014). Studies have demonstrated that achieving PA recommendations is not protective against the health risks of SB (Owen et al. 2010; Tremblay et al. 2010). As with other industrialised countries, in Aotearoa New Zealand (hereafter New Zealand), children's physical activity levels are decreasing alongside increasing sedentary time (Smith et al. 2018).

Screen-based SB, in particular TV viewing, is the most frequently assessed SB in children and youth. Studies have found low socioeconomic status (SES) is correlated with higher screen-based SB among youth (Gebremariam et al. 2015). However, screen-based SB does not reflect total sedentary time (Verloigne et al. 2013). An analysis of associations between total SB and SES found low SES was linked with higher TV viewing time but lower total (accelerometer-measured) SB time (Coombs et al. 2013).

Work exploring time use patterns of children in New Zealand indicated children residing in more deprived neighbourhoods had higher levels of SB than their peers from less deprived neighbourhoods (Zhao et al. 2019). Other studies have also shown residing in more deprived areas was associated with increased PA in children (Oliver, Mavoa et al. 2015). These studies revealed the importance of the time before and after school for accumulating PA, in line with earlier findings showing the end of the school day is a 'critical window' for promoting PA (Arundell et al. 2015; Atkin et al. 2008). Time spent outdoors is related to significantly higher levels of PA (Cleland et al. 2008; Cooper et al. 2010), making the outdoor neighbourhood environment important for supporting PA during the critical window period.

Evidence is mounting to support the association between neighbourhood built environments and children's PA and SB (de Vet, de Ridder, and de Wit 2011; Hinckson et al. 2017; Oliver, Mavoa et al. 2015; Smith et al. 2017). Using a socio-ecological approach, these studies have found environmental as well as individual and personal factors influence health behaviours (Sallis, Owen, and Fisher 2015). For example, neighbourhood streetscape design and availability of and access to public spaces such as playgrounds, parks, and greenspaces are associated with children's play and levels of PA (Carroll et al. 2015; Davison and Lawson 2006; Lachowycz et al. 2012; Oliver, Mavoa et al. 2015; Smith et al. 2017) and SB (Bejarano et al. 2019; Hinckson et al. 2017).

A third-place framework therefore offers a useful approach for considering how neighbourhood environments affect children's play and other PA (Carroll et al. 2015; Kearns et al. 2015; Oldenburg 1989). This framework distinguishes between the more defined and confined physical and social environments of home (first place) and school (second place), and the accessible public spaces (third place) of a neighbourhood. Furthermore, third places used by children can be divided into destinations (e.g. parks, playgrounds, shops), threshold spaces (e.g. semi-public spaces adjacent to home, such as driveways, grass verges and car parks), and transitory spaces (e.g. the routes that link children's daily destinations, such as footpaths, alleyways, pavements, streets) (Carroll et al. 2015).

Besides the neighbourhood built environment, studies show that parents' perceptions of the neighbourhood environment are also associated with children's PA levels in terms of active independent mobility trips (i.e. travelling and playing outside the home environment without being accompanied by an adult). Lin et al. (2017) found that parents' perceptions of neighbourhood social cohesion and social connectedness were significantly associated with independent mobility trips in

8–13 year-old children. Children of parents who perceived their neighbourhood as more cohesive (in terms of higher levels of trust, familiarity, and mutual support) and more connected (in terms of more network ties between the adults and children living in the same neighbourhood) engaged in higher levels of independent mobility trips.

The aim of this study is to understand the relationship between third-place play, parents' perceptions of their neighbourhood, and children's PA and SB during weekday out-of-school hours, a critical window for PA accumulation. This study takes a child-centred approach, utilising methods that capture children's voices and facilitate their active participation (Barker and Weller 2003; Carroll et al. 2015). Web-based public participation Geographic Information Systems (PPGIS) programmes have been successfully used in several countries to conduct child-centred research (Kyttä et al. 2018). PPGIS methods allow children's perceptions of place (the 'soft' place-based data on personal experiences) to be analysed alongside the built environment of the neighbourhoods (the 'hard' objective environmental data gathered using GIS) (Kyttä, Broberg, and Kahila 2012). This research examines children's use of third places during weekday out-of-school hours and parents' self-reported views of the neighbourhood environment, and their association with the percentage of time spent by children in SB, LPA and MVPA, as measured by accelerometry.

Methodology

This study analyses data from the Neighbourhoods for Active Kids (NfAK, 2015–2018) study, a cross-sectional, observational study based in New Zealand. The design protocol for the study is described in detail elsewhere (Oliver et al. 2016), however brief details pertaining to the present analyses are described here. Overall, the NfAK study examines how neighbourhood built-environments are associated with the independent mobility, active travel, physical activity and neighbourhood experiences of children aged 8–13 years in primary and intermediate schools across Auckland, New Zealand's largest city.

Participant recruitment

Nine neighbourhoods in Auckland were selected for recruitment based on diversity of school and neighbourhood-level variables (socio-economic status, child-specific walkability, and child-specific destination accessibility) and geographic spread across the city. One intermediate school (middle/junior high, children from school years 7–8) and a contributing primary school (elementary schools, children from school years 5–6) were recruited from each study neighbourhood. Due to the small number of eligible students in one contributing primary school, an additional contributing primary school was recruited for one neighbourhood. A total of 1102 students aged 8–13 years from 19 schools participated in the study. Data were collected from February 2015 to September 2016. Ethical approval to conduct the study was provided by the host institutions' ethics committees (AUTEC, 14/263, 3 September 2014; MUHECN, 3 September 2014; UAHPEC, 9 September 2014).

Measures

Child measures

Use of third-places. Trained researchers visited the schools during school hours to collect data with the child participants. As part of an interactive online PPGIS survey, children were asked: 'Do you ever play outside right next to your house/apartment (e.g. driveways, carparks, grassy areas)?' If children responded yes, they were asked where they played and given a range of responses to choose from (driveway(s), trees, grassy areas, pavement/footpath/verge, on the street, in the carpark, in a stairwell/foyer/corridor, or other (state)). These pre-defined threshold and transitory places were identified as important places for play in earlier research with children residing in urban Auckland neighbourhoods (Carroll et al. 2015).

Children were also asked to map destinations in the PPGIS survey they went to in and around their neighbourhood, and to indicate their mode of travel to that destination. Destinations that children travelled to actively were extracted and sorted using a combination of general categories e.g public open space, coastal, rural, business, general and special purpose (Auckland Parcel Group Zoning data 2013) and specific places such as bakeries, bus stops, community hall, supermarkets, convenience stores, restaurants, and libraries that were within 50 metres radius (using Google Places API).

Children's responses from the survey question and mapping activity were categorised according to four third-place variables: (1) *near-home green place* (e.g. trees and grassy areas); (2) *near-home street place* (e.g. driveways, footpath, pavement, verge, street, carpark); (3) *public open place <5k from home* (e.g. parks, beaches); and (4) *public-in-door place <5k from home* (e.g. shops, restaurants, libraries). Responses were dichotomised into yes or no responses to indicate whether the child noted playing at relevant locations or used relevant locations for each category.

Physical activity. PA was measured using 7-day accelerometry. Participants were asked to wear an Actigraph GT3X+ accelerometer fixed to an elastic belt (Actigraph, Pensacola, Florida, USA) worn around the waist for seven days. Units were initialised and data downloaded in Actilife V.6. A raw data sample frequency of 30 Hz was specified. Data were aggregated to 30s intervals using the low frequency extension (LFE) filter and saved as epoch files. Files were then converted to.csv within Meterplus (Santech, San Diego, California, USA). Non-wear time was classified as 60 min or more of consecutive zero counts (Oliver et al. 2011). Accelerometer count thresholds from Evenson et al. (2008) were applied to classify time spent in SB, LPA, and MVPA. These data were then aggregated per person per day. All days (inclusive of the first and last days) were required to be included in the analyses if the minimum wear time criteria of 10 h per weekday and 8 h per weekend day were achieved (Cain 2013). Percentage of time spent in SB (accelerometer counts < 100), LPA (accelerometer counts between 101 and 748) and MVPA (accelerometer counts >749 counts/30 s) was used in the analyses.

Out-of-school hours on weekdays were between 3pm (when school finishes) and 9am (when school starts). Individual weekdays were included in the analyses where 3 or more hours of data remained (60% minimum data inclusion) (Cooper et al. 2010). Data for out-of-school time were extracted using R (R Core Team 2013), and average counts per hour and %MVPA were then calculated for these periods for each school day.

Parent measures

Telephone interviews with parents were conducted to collect sociodemographic information for the child and household, and measure parents' neighbourhood perceptions.

Perception of neighbourhood cohesion. Neighbourhood social cohesion was measured via survey items adapted and modified from Sampson, Raudenbush, and Earls's (1997) social cohesion scale. Parents were asked to what extent they agreed with the following seven statements about the neighbourhood they lived in: 'People are willing to help'; 'Neighbours watch out for kids'; 'It's a close knit neighbourhood'; 'I can borrow $10 from a neighbour'; 'If there is a problem with neighbours we can deal with it if needed, e.g. dogs noise, rubbish'; 'The neighbours cannot be trusted (reverse coded)'; and 'People will take advantage of you (reverse coded)'. A five-point Likert scale was used, with scores ranging from 5 (strongly agree with the statement) to 1 (strongly disagree with the statement). An average score for each respondent was calculated over the seven items, with higher scores denoting stronger neighbourhood cohesion (M = 3.72, SD = .51). Cronbach alpha coefficients show good internal consistency (0.80).

Perceptions of neighbourhood social connectedness. Neighbourhood social connectedness was measured via survey items adapted from Sampson, Morenoff, and Earls's (1999)

intergenerational closure scale. Parents were asked to what extent they agreed with the following five statements about the neighbourhood they lived in: 'Parents in this neighbourhood know their children's friends'; 'Adults in this neighbourhood know who the local children are'; 'There are adults in this neighbourhood that the children can look up to'; 'Parents in this neighbourhood generally know each other'; and 'You can count on adults in this neighbourhood to watch out that children are safe and don't get in trouble'. A five-point Likert scale was used, with scores ranging from 5 (strongly agree with the statement) to 1 (strongly disagree with the statement). These five questions tap varied possibilities for intergenerational social connections and active support of neighbourhood children by adults – whether or not the adults are parents (Sampson, Morenoff, and Earls 1999). An average score for each respondent over the five items was calculated, with higher scores denoting stronger perceptions of neighbourhood social connectedness (M = 3.65, SD = .66). Cronbach alpha coefficients show good internal consistency (0.85).

Demographic and neighborhood deprivation measures

Child demographics were provided by the parents (child ethnicity, age, sex, and residential address). Child ethnicity was coded into five dichotomous variables for analysis (i.e. New Zealand European, Māori, Pacific people, Asian, and Other).

Dwelling type was obtained from parents. Responses were coded into two dichotomous variables for analysis – House and Other (such as flat, apartment, and units).

Neighbourhood level deprivation was obtained for each child based on their geocoded residential address according to the New Zealand Index of Deprivation (NZDep2013). The NZDep2013 is a meshblock-level index of deprivation derived from 2013 census data relating to income, home ownership, employment, qualifications, family structure, housing, and access to transport and communications. Meshblocks are the smallest geographic unit defined by Statistics New Zealand for reporting neighbourhood statistical data (with a population of around 60–110 people).

Data analysis

PPGIS survey responses were downloaded as.csv files from www.maptionnaire.com. Location data (x-y coordinates) and mode of travel for mapped settings were also extracted as.csv files from maptionnaire. Locations were geocoded in ArcGIS 10.7.1, and categorised for place type using mainly Auckland Parcel Group 2013 zoning data. Specific data from the Google Places API within 50 m of the child's destination were included when available. Data for locations where children reported travelling actively to were extracted for analysis. Distance from children's geocoded residential addresses to each geocoded location was calculated using origin-destination walkable network path in ArcGIS and a specific toolbox and script were created for grabbing google places within 50 m of the destination. Destinations <5 km from the child's usual residential address were included in analyses. Survey responses and places visited from the mapping data were then combined with demographic datasets in Microsoft Excel. These datasets were then uploaded into SAS 9.4 for analysis.

All data analysis was undertaken using SAS 9.4 and statistical significance was set at $\alpha = 0.05$. Prior to analysis, PA, parental neighbourhood perceptions, use of third places, gender, school year, ethnicity, and neighbourhood deprivation were examined for accuracy of data entry, distributions, missing values, and problematic outliers. Analyses were conducted for weekday PA, which was broken down into proportion of time spent in SB, LPA and MVPA.

Three regression models were created (Model 1–3), one for each of the outcome variables: Time spent in SB (Model 1), Time spent in LPA (Model 2), and Time spent in MVPA (Model 3). For each outcome, a beta linear regression model was performed using the GLIMMIX procedure in SAS. Random effects associated with the schools and locations were explored across the models, but

were found not statistically significant and therefore not included in the final analysis. Third-place play and parent neighbourhood perceptions (cohesion and social connectedness), gender, ethnicity, child age, deprivation, and dwelling type (house vs other) were considered as independent variables. Categorical/dichotomic variables were included in the models as dummy variables. School type, school decile, and child's school year were not included in the regression models to avoid multi-collinearity problems. Where there was missing data, this was addressed by list wise deletion. No interactions were specified.

Each regression model began with the inclusion of all the independent variables. Any variables that were not statistically significant (at $P < .05$) were removed from the model in a stepwise fashion until no nonsignificant variables remained.

Results

Participants

A total of 1102 student records were available (for a description of the full sample please refer to Egli, Mackay, et al. 2020). However, children who did not identify any third places (from the survey item and mapping activity in the PPGIS) or those who had no recorded values for the PA measure (on the accelerometer) were eliminated from the analysis. The final sample retained in this analysis comprised 856 children. A few of the children's ages have been imputed using school year as the proxy. Characteristics of participants included in analyses are provided in Table 1.

Table 1. Participant characteristics ($N = 856$).

	Number or Mean (% or min-max)
Demographic variables	
Children's sex: Male	409 (47.8%)
Female	447 (52.2%)
Children's age	10.7 (8–13)
Children's ethnicity: New Zealand European	351 (41.0%)
Māori	107 (12.5%)
Pacific Island	123 (14.4%)
Asian	120 (14.0%)
Other	155 (18.1%)
Dwelling type: House	659 (77.0%)
Other (e.g. flat, apartment, units)	197 (23.0%)
NZDep2013: Decile 1 (least deprived area)	57 (6.7%)
2	184 (21.5%)
4	66 (7.7%)
5	10 (1.2%)
6	118 (13.8%)
8	70 (8.2%)
9	196 (22.9%)
Decile 10 (most deprived area)	155 (18.1%)
Third-place play:	
Near-home green place: Played there	675 (78.9%)
Did not play there	181 (21.1%)
Near-home street place: Played there	611 (71.4%)
Did not play there	245 (28.6%)
Public open space near home: Played there	356 (41.6%)
Did not play there	222 (25.9%)
Did not answer	278 (32.5%)
Public in-door space near home: Played there	186 (21.7%)
Did not play there	392 (45.8%)
Did not answer	278 (32.5%)
Parental perceptions of neighbourhood	
Perceptions of neighbourhood cohesion	3.72 (1.78–5.00)
Perceptions of neighbourhood connection	3.65 (1.60–5.00)

Third-place play, parental perceptions, and children's physical activity

Results from the analyses are provided in Table 2. A majority of children indicated they played at some green places or street places near home in the survey responses (78.9% and 71.4% respectively). Children who played in green places near home spent less time in SB and more time in LPA. Children who played in street places near home spent more time in MVPA. Mapping of public open spaces or public in-door space <5 k from home occurred less often (41.6% and 21.7% of mapped these locations, respectively), and neither was related to time children spent in SB or either of the two PA levels.

Parents' perceptions of neighbourhood cohesion and connectivity were not associated with children's time spent in SB, nor their time spent in LPA or MVPA. However, further regression analysis was conducted to examine the relationships between parents' perceptions of neighbourhood environment and children's third-place play. We fitted four logistic regression models, one for each of the children's third-place play outcomes: near home green place, near home street place, public open place near home, and public in-door place near home. The results revealed that parents' perception of **neighbourhood connectivity** were positively related to children's likelihood of playing at green places near home (estimate = 0.39; SE = 0.12; p-value = 0.001) and at street places near home (estimate = 0.23; SE = 0.11; p-value = 0.04). Conversely, parents' perception of **neighbourhood cohesion** was not related to children's third-place play. Results from these analyses are provided in Table 3.

There was significant ethnic differences in children's time spent in PA and SB. Compared to children of New Zealand European ethnicity, children belonging to Māori or Pacific ethnic groups spent more time in both LPA and MVPA (Pacific children also spent less time in SB) outside school

Table 2. Association between demographics, third-place play, parental neighbourhood perceptions and children's time spent in SB, LPA and MVPA.

	Time spent in SB[a] (Model 1)			Time spent in LPA[b] (Model 2)			Time spent in MVPA[c] (Model 3)		
Effect	Estimate	S.E.	*P*-value	Estimate	S.E.	*P*-value	Estimate	S.E.	*P*-value
Intercept	0.811	0.147	<.0001	−1.205	0.044	<.0001	−3.229	0.222	<.0001
Child ethnicity: Asian vs NZ Euro	0.045	0.049	0.3650	0.003	0.043	0.9484	−0.173	0.074	**0.0196**
Māori vs NZ Euro	−0.092	0.053	0.0793	0.121	0.044	**0.0062**	0.153	0.072	**0.0333**
Other vs NZ Euro	−0.139	0.042	**0.0009**	0.159	0.038	**<.0001**	0.021	0.064	0.7495
Pacific vs NZ Euro	−0.195	0.051	**0.0002**	0.218	0.041	**<.0001**	0.207	0.067	**0.0020**
Child sex: Male vs Female	(Not included in final model)			(Not included in final model)			0.259	0.046	**<.0001**
Child age	0.029	0.013	**0.0235**	(Not included in final model)			−0.069	0.020	**0.0006**
Dwelling type: House vs Other	0.086	0.035	**0.0154**	−0.090	0.032	**0.0056**	(Not included in final model)		
NZ Deprivation index	−0.012	0.006	**0.0485**	(Not included in final model)			(Not included in final model)		
Near home green place	−0.082	0.037	**0.0277**	0.074	0.034	**0.0302**	(Not included in final model)		
Near home street place	(Not included in final model)			(Not included in final model)			0.161	0.052	**0.0021**
Public open place near home	(Not included in final model)			(Not included in final model)			(Not included in final model)		
Public in-door place near home	(Not included in final model)			(Not included in final model)			(Not included in final model)		
Perceptions of neighbourhood cohesion	(Not included in final model)			(Not included in final model)			(Not included in final model)		
Perceptions of neighbourhood connection	(Not included in final model)			(Not included in final model)			(Not included in final model)		
Scale parameter	25.671	1.228		32.579	1.558		72.389	3.698	

[a]SB = sedentary behaviour.
[b]LPA = light-intensity physical activity.
[c]MVPA = moderate-to-vigorous physical activity.

Table 3. Associations between demographics, parental neighbourhood perceptions and children's third-place play.

	Near home green place ($n = 880$)			Near home street place ($n = 880$)			Public open near home ($n = 611$)			Public in-door place near home ($n = 753$)		
Effect	Estimate	S.E.	*P*-value	Estimate	S.E.	*P*-value	Estimate	S.E.	*P*-value	Estimate	S.E.	*P*-value
Intercept	0.615	0.917	0.502	0.078	0.410	0.850	−0.079	0.568	0.890	−0.474	0.151	0.002
Child age	−0.146	0.069	0.035									
Dwelling type: House vs Other	0.848	0.286	0.003							−0.311	0.176	0.078
Perception of neighbourhood cohesion												
Perception of neighbourhood of connection	0.385	0.120	0.001	0.225	0.111	0.043						

Note: Child ethnicity, sex and NZ Deprivation index were not significant.

hours during weekdays, while Asian children spent less time in MVPA (than children of New Zealand European, Māori and Pacific ethnicities).

Boys were more likely than girls to spend time in MVPA outside school hours on week days, but there were no gender differences regarding time spent in SB and LPA. Older children were more likely to engage in SB and less likely to spent time in MVPA during weekdays outside of school hours. Children living in a house had more SB and spent less time in LPA than children living in other dwelling types (such as flats, apartments, and units). The New Zealand Deprivation Index was associated with SB (such that children residing in more deprived areas were less likely to be sedentary), but area deprivation was not associated with LPA or MVPA.

Discussion

This study examined the relationship between third-place play, parents' perceptions of neighbourhood, and children's time spent in PA and SB during weekday out-of- school hours in a large sample of children aged 8–13 years. Using a child-centred and mixed-methods approach, this study provides quantitative empirical evidence to show that children's engagement in third-place play is significantly associated with their PA levels (as measured by accelerometer).

This is the first study (to the authors' knowledge) to link different types of third-place play and different intensities of PA. Interestingly, the *destination* type of the third places (e.g. parks, playgrounds, shops, libraries), regardless of whether public open space or in-door space, was not associated with children's time spent in either light intensity (LPA) or moderate- to-vigorous intensity physical activity (MVPA). The unexpected null finding for public open space is contrary to previous research (Cleland et al. 2008; Cooper et al. 2010). This finding may be due to the fact that less children were able to visit these places during weekday out-of-school hours (41.6% and 21.7% of children mapped public open space and public in-door space, respectively). For those who did map these locations, there was no clear and consistent relationship pattern between visiting these places and the amount of time spent in PA. It is also possible that type of public open space plays an important role in promoting PA and the broad measure used in this study was insufficiently specific to identify such relationships. For example, emerging evidence suggests that green space may be especially important for encouraging PA in children (Lachowycz et al. 2012; Ward et al. 2016). Moreover, we used a relatively generous distance threshold of 5 km for including mapped locations in order to capture the array of possible third places important for children's PA, and included only those that children got to actively. It is possible that locations further from home are visited less (and thus have less of an impact on PA) than settings closer to home, even if children are driven to these locations. The use of a shorter distance threshold and inclusion of settings that children were driven to may have yielded different results.

In our study, we re-grouped *threshold* third places (e.g. semi-public spaces adjacent to home, such as driveways, grass verges and car parks) and *transitory* third places (e.g. the routes that link children's daily destinations, such as footpaths, alleyways, pavements, streets) into either 'green place near home' or 'street place near home'. Our results show that playing in these types of third place was significantly associated with children's time spent in SB and PA. Specifically, children who played at **green places** near home spent more time in LPA (and less time in SB) during weekday out-of-school hours, while children who played in **street places** near home were more likely to engage in MVPA. As noted in another paper from our NfAK study, the most common forms of play for children 8–13 years old besides sports are riding bikes/scooters/skateboards, and running (Egli, Villanueva, et al. 2020). Therefore, when children in the current study were 'playing' on the street near home, they were very likely engaging in this type of higher intensity PA (biking, scootering or running), hence accumulating more time in MVPA.

Our results initially suggested parents' perceptions of the neighbourhood social environment were not directly associated with children's PA level. However, further analysis revealed that

parents' perceptions of neighbourhood connectivity were significantly associated with children's likelihood of playing in *threshold* and *transitory* third places (which in turn was associated with children's time spent in PA). A higher level of neighbourhood social connectedness provides casual monitoring and benign surveillance of local children's outdoor activities (Witten et al. 2013), and is favourably associated with children's independent mobility (Lin et al. 2017) and children's active school travel (Ikeda et al. 2019). In our study, the children of parents who perceived their neighbourhood as more connected (in terms of more network ties between the adults and children in the neighbourhood, and active support of neighbourhood children by adults) were more likely to play in green places and street places near home. This finding provides further evidence that perceptions of neighbourhood social environment contribute to parents' willingness to let their children play outside and children's decision-making regarding their play in third places. Future research could further explore the pathways between parent perceptions, neighbourhood play, and resulting impacts on children's PA. Research exploring links between children's active travel to and from school and their third-place play would also be interesting. A previous study has documented accounts of children's play on the journey to school (Carroll et al. 2019), and the findings of the current study also hint at this. For instance, children noted active travel school journeys gave them 'time to play and talk with friends' – and also the option of visiting third places such as parks and shops en-route (Egli, Mackay, et al. 2020).

With regard to housing type, the results show that children living in a house were more sedentary and spent less time in LPA than children living in other dwelling types. This is of particular interest in Auckland where the city's traditional low density urban form is changing under new regulations to encourage densification (Auckland Council 2021). Resistance to densification is often couched as concern that higher density housing is unsuitable for children and families. These findings suggest that as long as threshold spaces are incorporated into multi-dwellings complexes, or available nearby, third-place play spaces may offer an adequate alternative to the traditional backyard. In light of the findings on parent perceptions of social connectedness, a distinction may need to be made between medium density dwellings designed to enable social mingling between residents and multi-story apartment blocks that can bar lift access to all but residents of a floor (Carroll et al. 2015). The findings suggest environments that encourage social relationships between neighbourhood parents and children, as well as third-place play spaces, best support children's play and PA accumulation.

Our study also shows that socio-demographic factors play an important role in these relationships. The relationships we found were in the expected directions, and in keeping with previous research (e.g. Butte et al. 2014; Oliver, Mavoa, et al. 2015). In particular, boys spent more time in MVPA than girls outside of school hours during weekdays. Age was negatively associated with time spent in MVPA and positively related to time spent in SB. Differences between ethnic groups were also observed, with children of Māori or Pacific ethnicity significantly more likely to engage in both LPA and MVPA, and those of Asian ethnicity accumulating significantly less MVPA than their counterparts. Similar to past studies (e.g. Coombs et al. 2013) using accelerometer-measured SB (rather than screen-based SB), our findings also suggest that living in more deprived areas (as indicated by higher decile ratings on the New Zealand Deprivation Index) was associated with lower proportions of SB time.

The main limitation of this study is its cross-sectional design. Although our results show an association between children's third-place play and time spent in PA and SB, and also an association between parents' perceptions of neighbourhood connectivity and children's third-place play, causality cannot be determined, and reverse causality cannot be ruled out. Also, our sample did not aim to be representative of New Zealand school students and any generalisation of findings beyond the sample requires caution.

Another limitation of this study is the succinct nature of the PPGIS survey responses when compared to qualitative interview or focus group methods, where meaning can be more easily ascertained and confusing responses clarified. For example, we did not include school as a place of

interest in this study, because it was unclear from the PPGIS mapping whether or not children were mapping schools from the perspective of going there out of school time. Overall, schools were marked 169 times, therefore, some of these datapoints were marked as out-of-school destinations but we cannot ascertain which ones.

A strength of this study is the categorisation of third places. This study is also the first to examine children's engagement in third-place play and the relationship to their time spent in PA. Another strength of this study is the use of a child-centred and mixed methods approach. The child-centred approach respects children's ability to answer questions about their own experiences, and mixed methods provide valuable insights to help interpret quantitative findings. This study is also strengthened by its large and diverse sample size of over 1100 children from a large, socio-economically and culturally diverse city (Auckland). Future studies of this type are warranted given the considerable depth and breadth of understanding they provide about children's geographies and wellbeing. For example, the NfAK study has yielded insights with regard to: comparisons of children's mapped routes and GIS-derived routes to school (Ikeda et al. 2018); quantitative modelling of factors associated with active school travel (Ikeda et al. 2019); exploring the role of school policies and practices for supporting active school travel (Ikeda et al. 2020); understanding children's perceptions and use of neighbourhood destinations (Egli, Villanueva, et al. 2020) and perceptions of their school journey (Egli, Mackay, et al. 2020); associations between deprivation, food environments, nutrition behaviours, and children's health (Egli, Hobbs, et al. 2020); visualising links between 24-hour activity behaviour with weight status and neighbourhood context (Zhao, 2019); measuring children's exposure to unhealthy food and beverage advertising (Egli et al. 2018); examining links between parent built environment perceptions and their child's independent mobility (Smith et al. 2019); and most recently, developing measures of children's activity spaces and associations with PA and sociodemographic characteristics (Hasanzadeh et al. 2022). Future opportunities exist to harness this large and complex dataset, including using agent-based modelling (e.g. see Almagor et al. 2021) and exploring links between children's mapping data and parent and school representative perceptions.

Conclusion

Children aged 8–13 years with parents who perceived their neighbourhood as more connected were more likely to play in *threshold* and *transitory* third places (i.e. green places and street places near home). Playing in green places near home was negatively associated with the time children spent in SB and positively related to time spent in LPA. Children who played in street places near home accumulated more MVPA during weekday out of school hours than those who did not. Encouraging children's play in third places and ensuring street environments are safe places for children to play could be pathways to decreasing SB and fostering health-promoting levels of PA in children.

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