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Neighbourhoods for Active Kids: study protocol for a cross-sectional examination of neighbourhood features and children's physical activity, active travel, independent mobility and body size

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ABSTRACT

Introduction: New Zealand children's physical activity, including independent mobility and active travel, has declined markedly over recent decades. The Neighbourhoods for Active Kids (NfAK) study examines how neighbourhood built environments are associated with the independent mobility, active travel, physical activity and neighbourhood experiences of children aged 9–12 years in primary and intermediate schools across Auckland, New Zealand's largest city.

Methods and analysis: Child-specific indices of walkability, destination accessibility and traffic exposure will be constructed to measure the built environment in 8 neighbourhoods in Auckland. Interactive online-mapping software will be used to measure children's independent mobility and transport mode to destinations and to derive measures of neighbourhood use and perceptions. Physical activity will be measured using 7-day accelerometry. Height, weight and waist circumference will be objectively measured. Parent telephone interviews will collect sociodemographic information and parent neighbourhood perceptions. Interviews with school representative will capture supports and barriers for healthy activity and nutrition behaviours at the school level. Multilevel modelling approaches will be used to understand how differing built environment variables are associated with activity, neighbourhood experiences and health outcomes.

Discussion: We anticipate that children who reside in neighbourhoods considered highly walkable will be more physically active, accumulate more independent mobility and active travel, and be more likely to have a healthy body size. This research is timely as cities throughout New Zealand develop and implement plans to improve the liveability of intensifying urban neighbourhoods. Results will be disseminated to participants, local government agencies and through conventional academic avenues.

Strengths and limitations of this study

- Strengths of the study are the strategic school recruitment methods to ensure a large sample of children, heterogeneous in terms of socioeconomic deprivation, ethnicity, age and geographic location.
- The use of child-centred methods to collect information on children's use and perceptions of their neighbourhood environments is anticipated to garner unique insights that would not otherwise be captured.
- Objective measures of physical activity, body size and the neighbourhood built environment are key strengths.
- Limitations are that the data are cross-sectional, so causality cannot be implied. Data are being collected in one New Zealand city only. Nutrition and travel behaviours are being self-reported by children; however, the concurrent proxy reporting of these behaviours by parents will be used to improve accuracy of these variables.

INTRODUCTION

Physical activity is fundamental to optimal health, development and well-being in children.[1 2] Even modest amounts of activity can have marked health benefits in high-risk children (eg, who are obese or have high blood pressure).[3] Active travel (eg, walking or cycling to destinations) and independent mobility (ie, unsupervised travel and neighbourhood play) offer important opportunities for children to accumulate physical activity.[4–6] Both behaviours offer numerous cobenefits—for example, active travel is associated with the maintenance of a healthy weight[7] and improved cardiovascular risk profiles.[8] Independent mobility promotes ongoing navigation, risk assessment and decision-making by the child, providing learning opportunities not available when supervised by an adult.[9 10] Children's travel behaviours tend to be less structured than more purposeful adult activity and travel patterns.[11] When a child is walking with an adult they travel faster and more linearly and purposively compared with when they travel alone or with peers. Without journey supervision, children are free to explore, play and undertake challenging activities (eg, climbing trees) that may be prohibited by safety-conscious parents.[12]

Despite such clear benefits, the prevalence of these behaviours is low in New Zealand children.[13] While some evidence of flattening out has occurred,[14] recent decades have mostly seen significant declines in these behaviours for children.[15–17] Concurrently, increasing body sizes in New Zealand children have risen to the point that New Zealand has one of the highest rates of childhood overweight and obesity worldwide.[18] Neighbourhoods can provide children important opportunities to accumulate health-promoting levels of physical activity through active travel and independent mobility, being active at destinations (eg, parks) and generally 'colonising' local settings.[19–21]

Associations between children's physical activity and neighbourhood features such as dwelling density, destination accessibility,[22] street connectivity[23 24] traffic exposure (negative), streets conducive to walking and cycling,[25] park space and multiuse path space[26] have been observed. A time-use examination of weekend physical activity in children aged 5–17 years revealed associations between physical activity and destination availability, dwelling density and active transport infrastructure.[11] Regional and sociodemographic differences have been observed; for example, one recent US investigation revealed that areas profiled as having higher walkability and recreation/park access were associated with children's moderate-to-vigorous physical activity (MVPA) accumulated out of school hours in one study region (San Diego), but not another (Seattle/King County).[27] In older (12–15 years), but not younger, children higher dwelling density and street connectivity have been associated with increased physical activity,[24] although lower dwelling density has also been found to increase out-of-school physical activity.[11]

Distance to school has consistently been the strongest built environment factor linked with children's active travel to school,[28 29] and to neighbourhood destinations in general.[25] However, associations between other built environment factors and active travel (or independent mobility) is limited and inconsistent, with findings often varying by age, sex, ethnicity and socioeconomic factors.[22 30 31] Some work has shown higher street connectivity and lower traffic volumes are associated with active travel to school, while others have shown conflicting results.[32]

Rapid urbanisation and limited planning for children in urban environments has led to increasingly constrained opportunities for children's engagement with their neighbourhood.[33 34] While these changes likely reduce activity behaviours overall, there are also examples of the resilience and innovative capacity of children to reframe what an activity-friendly environment means to them. For example, recent work with Auckland children revealed a high use of 'third place thresholds' (eg, driveways, grass verges, stairwells, etc) for play opportunities.[21] Such research that considers children as active agents in the research process, using child-centred methods, and gathering information from children's perspectives, provides unique strengths in terms of identifying features and issues of importance that might not otherwise be captured.[35]

Other challenges exist in terms of understanding the impact of the built neighbourhood environment on children's activity behaviours and health outcomes. Neighbourhood delineation is perhaps the greatest issue,[36] with differential relationships with activity observed by neighbourhood buffer type (eg, Euclidean, street network) and buffer size (eg, 400 and 800 m).[26] In part this is likely due to the 'constant neighbourhood size trap',[37] recognising that individuals have different levels of exposure to their local neighbourhood, and that the shapes of these 'activity spaces' may also differ.[38 39]

Parenting practices are an additional consideration as parents act as gatekeepers to children's everyday mobility.[40] Car reliance, time scarcity, safety-conscious parenting practices, technology use and decline in traditional neighbourhood relationships are among the potential contributing factors in the decrease in children's independent mobility and neighbourhood physical activity.[41 42] Parental concern about their child's safety appears to be the greatest social factor influencing children's active travel and independent mobility,[10 43] with 'good parenting practice' conceived as chauffeuring children to a wide range of activities and destinations.[44] Paradoxically, this 'social trap' created by parents chaperoning children in cars, is of immediate public health significance as it reduces passive surveillance of those children who remain on the street (the safety in numbers effect).[45] Furthermore, this practice reduces driver's awareness and safety practices relating to pedestrians.

The Neighbourhoods for Active Kids (NfAK) study aims to gain a deeper understanding of the relationship between the urban environment and children's activity behaviours and health outcomes. Data will be collected with children, their parents and school representatives using a range of measures to assess factors of importance across the home, school, and neighbourhood physical and social environments. A focus of this research is the use of child-centred participatory geographic information systems (GIS) methods to gather information on children's travel, independent mobility and neighbourhood perceptions, experiences and engagement.

DESIGN AND METHODS

NfAK is a cross-sectional study with children aged 9–12 years, residing in Auckland, New Zealand's largest city (~1.4 million residents, comprising 30% of the total population). Children are being recruited through intermediate (middle/junior high) schools (7–8 years, approximate ages 11–12 years) and a contributing primary school (including children from 5–6 years only, ages 9–10 years) across eight neighbourhoods. Sample size calculations showed ~125 children per neighbourhood (ie, primary and intermediate school dyad), and at least 8 neighbourhoods (16 schools and ~1000 participants in total) will be required to enable the detection of meaningful and significant differences in active travel, independent mobility and MVPA (with power of 0.8 and significance set at α=0.05).

Information is being collected with children (body size, accelerometry, interactive mapping softGIS survey), their parents (computer-aided telephone interview, CATI) and school representatives (face-to-face interview). A range of GIS-based measures of the neighbourhood environment will be developed. Data collection started in February 2015, and is anticipated to be complete by September 2016.

Neighbourhood selection

For the purposes of this study, a study neighbourhood is defined as the catchment area around a state coeducation intermediate school (7–8 years) and a contributing primary school (1–6 years). Diversity in the population sample across key variables is facilitated by use of a matrix encompassing neighbourhood-level socioeconomic, walkability and destination accessibility features to identify areas for recruitment. Child-specific neighbourhood walkability,[32] and child-specific neighbourhood destination accessibility (NDAI-C)[46] have been calculated for each intermediate school in Auckland. Schools in the highest and lowest tertiles for these variables are then tabulated against their decile rating (an area-level measure of socioeconomic deprivation).[47] Schools are identified for invitation from this matrix to ensure a spread across decile ratings (high, medium, low). Geographic spread across the city is also being considered in neighbourhood selection.

School and participant recruitment

Principals or deputy principals of each school (one intermediate school and a contributing primary school within each neighbourhood) are approached (by phone, email, face-to face) with an invitation for their school to participate in the study. They are provided with information sheets for the principal and teachers. Following school representative consent, students from classes of appropriate school years (selected by the school) are visited at the school by members of the research team, during class time, provided with verbal and written information about the study and invited to participate. Researchers are available to answer any questions the students or teachers have at this time. Participant information sheets, assent forms and parent consent forms are left with students, who are given 2 weeks to return their assent and parent consent forms if they wish to participate. Schools are provided a summary report of findings for their school and koha (voucher) to acknowledge their time and support of the study at completion of data collection for their school.

Child measurement protocols

Trained researchers visit the school during school hours to collect data with child participants. During this time, participants complete an online interactive mapping survey (softGIS), have their body size measured and are fitted with their accelerometer as detailed below. Children are asked to wear the accelerometers over 7 consecutive days, recording attachment and removal of the devices daily in a compliance diary. Approximately 8 days after the first school visit, a research assistant returns to the school to collect accelerometers and compliance diaries. Participants are provided with a report of their physical activity results and koha (shopping mall voucher) to acknowledge their contribution to the study.

Physical activity

Participants are fitted with Actigraph GT3X+ accelerometers fixed to an elastic belt (Actigraph, Pensacola, Florida, USA), worn around the waist.[48–50] Units are initialised and data downloaded in Actilife V.6. A raw data sample frequency of 30 Hz is being specified, and all download options are checked (ie, steps, lux, inclinometer, low frequency extension enabled). Downloaded data are being screened at the completion of each school to identify any obvious accelerometer malfunctions or outliers.[51] Files are then converted to .csv within Meterplus (Santech, San Diego, California, USA) and accelerometer count thresholds of Evenson *et al*[52] employed to classify time spent sedentary and in MVPA. Non-wear time is being classified as 60 min or more of consecutive zero counts.[53] At least 7 hours of data are required for a valid day, and at least 3 valid days are required for inclusion in analyses of physical activity.[54]

Body size

Height (m), weight (kg) and waist circumference (cm) are being measured using a stadiometer, Seca scales and Lufkin tape measure, respectively. Body mass index (BMI) will be calculated as kg/m^2 and thresholds for BMI-derived overweight and obesity[55] and height-to-waist circumference[56] employed. Body size measures are being taken by trained researchers, in the same room as other participants, but behind a partial screen for privacy.

softGIS survey

An interactive, spatially referenced online survey tool is being used to capture survey items with children and conduct mapping exercises of routes to school and neighbourhood destinations of importance.[57] Prior to implementation in the current study, the survey was tailored for local use and piloted with children across a range of ages and technical skill levels. Subsequent adaptations to the survey were: removal of some items (eg, to shorten survey duration); reducing or rewording items (eg, items requiring estimation of portion sizes of food servings because this was too difficult); and adding an item to assess whether participants who were driven to school were comfortable to try mapping their route to school. Although children who walked, cycled or scootered to school were confident in the route mapping exercise, children who were driven often had difficulty describing their route to school. In contrast with earlier research, it was also identified that additional researcher support was required to aid children's comprehension and comfort in completing the survey. Accordingly, a maximum of four participants complete the survey at any given time, with four researchers available to provide one-to-one assistance with survey completion.

The neighbourhood mapping components of the survey was drawn from the earlier work of Kyttä *et al*.[57] Respondents are asked to indicate, on the online map, places they go in and around their neighbourhood. This item is intentionally open for interpretation by the child, in terms of defining 'neighbourhood' and identifying places of importance to them. On marking a destination, additional items on travel mode to that destination, accompaniment (alone, with other children but no adults, with an adult present), open-ended items about likes and dislikes and a 10 point sliding scale of how much the participant liked that destination (I do not like it here, I like it a lot) are asked. Children are also asked if there were other places they would like to go, but are not allowed to and if so, where they would like to go and what they would do there.

School travel: Usual mode(s) of travel to school are self-reported, and participants are asked to map their usual route to school, to report the frequency of travelling this route (all of the time, most of the time, sometimes, hardly ever/never), and asked about likes, dislikes and perceptions about their route to school. Fifteen items to assess motivations for travel behaviours have been drawn from earlier research using the reasoned action approach construct.[58 59]

Perceived neighbourhood and road safety is being assessed using four items regarding traffic volume around the school, volume of parked cars around the school, and sense of safety in the neighbourhood when with and without an adult.[60]

Use of third places is being captured using open and closed items to assess whether children play outside near their residence (eg, driveway, carpark, stairwell/foyer/corridor).[21] Accompaniment status when playing in these spaces is also captured (alone, with other children but no adults, an adult is present).

Independent mobility licence is being assessed using items from the Policy Studies Institute study of children's independent mobility.[15] Children are asked whether they are allowed to cross main roads on their own, cycle on main roads, go on local public transport on their own and cycle to local destinations (eg, friends) on their own. Participants are also asked whether they are allowed to do the following activities, by themselves, with other children (with no adult present), only if an adult was around or not at all: go to clubs/activities, go to the city centre/shopping malls, go to parks/sports facilities, go out alone after dark or go to their friends' houses.

Nutrition and food purchasing behaviours are measured using adapted items from the New Zealand Health Survey[61] and the New Zealand Child Nutrition Survey.[62] Pilot testing of the survey revealed a need to substantially simplify items to aid comprehension. Accordingly, children are being asked how often they: (1) consumed sugar-sweetened beverages such as fruit juice, fizzy drinks, cordial or sports drinks, (2) consumed foods such as sweet biscuits, chocolate, lollies (sweets), chips (crisps), cakes etc., (3) bought something to eat or drink on the way to school, (4) bought something to eat or drink on the way home from school and (5) bought food or drinks from school. Response options for all items are: every day, every week, every month, hardly ever/never or not sure. Images of example foods and drinks are also provided to aid comprehension.

School environment and policy

Telephone or face-to-face interviews are being conducted with a representative from each school (usually the principal or deputy principal). Interviews are semi-structured, with specific items around school policies and practices related to school travel (eg, walking school buses) and the school nutrition and physical activity environment.

School demographic information (total roll, ethnic composition, etc) is being obtained from the Ministry of Education 'education counts' website (http://www.educationcounts.govt.nz).

Home/family environment

Following conclusion of data collection within child participants, a CATI is being conducted with parents/caregivers of participating children. Surveys are delivered in English, Samoan, Tongan, Chinese or Korean, as required.

Sociodemographic and household factors are reported by parents/caregivers as follows: child ethnicity, sex, date of birth; house type, household composition, access to outdoor space (own garden, shared outdoor area, nearby park), home ownership status, car availability; and respondent's highest qualification, current employment situation and ethnicity. Socioeconomic status is being assessed using one item from the New Zealand Index of socioeconomic deprivation for individuals around having to purchase cheaper food in order to pay for other items.[63]

School travel: Usual mode of travel to and from school, accompaniment for these school trips, reasons for travel mode decision-making, relative importance of reasons, and role of trip chaining in school travel decision-making are being captured using items from the Kids in the City Study.[64]

Independent mobility licence is being assessed using items from the Policy Studies Institute as described above.[15] Respondents are also asked if their child has a mobile phone and if so, whether this gives them (the respondent) more confidence in letting their child to go out on their own. An open-ended item is used to identify factors that would make it better for children to travel independently in their neighbourhood.

Perceptions of neighbourhood safety, social cohesion and social connectedness are being captured using adapted items from Sampson *et al*.[65 66]

Usual time spent sitting in specific behaviours (watching television/videos/DVDs; using the computer, tablets or playing video games; reading, writing or doing homework not using the computer; riding in a car, bus, etc) is proxy-reported by parents/caregivers for their child, for weekdays and weekend days.[67]

Child nutrition behaviours are captured using items from the New Zealand Health Survey and Child Nutrition Survey as above, and include additional items on usual servings of fruit and vegetables per day.[61 62]

Streetscape audits

Pedestrian and cycling infrastructure, safety and aesthetic features of streets near participating schools will be audited using the New Zealand Systematic Pedestrian and Cycling Environment Scan a tool adapted for and used in New Zealand.[68] Segments will be audited virtually using Google Street View.[69]

Weather

Daily weather data (precipitation, hours of daylight, minimum and maximum temperature) will be freely downloaded from the New Zealand meteorological service (cliflo.niwa.co.nz).

GIS measures

GIS measures of the neighbourhood environment will be derived around each participant's residential and school address based on distance along the pedestrian network. Geographic data sets will be extracted using ArcGIS V.10.2 (ESRI, Redlands, California, USA). SoftGIS map data (polylines) will be imported into ArcGIS. A range of buffer sizes will be employed, and the utility of the softGIS neighbourhood destination mapping data to inform appropriate activity space buffers will be investigated. The following variables will be calculated:

Individual walkability measures: net residential density (ratio of residential dwellings to residential land area), street network connectivity (ratio of number of intersections with three or more intersecting streets per square kilometre to land area) and land use mix (an entropy index based on the presence or absence of five types of land use) will be calculated.[70]

A child-specific walkability index will be generated using: (1) the ratio of high-speed roads (>60 km/hour) to low-speed roads and (2) the ratio of the pedestrian network area to the maximum possible area within the defined boundary.[32]

Child-specific destination accessibility will be determined using the neighbourhood destination accessibility index for children.[71]

Availability of public open space will be calculated as the ratio of public open space (green space, parks, playgrounds) that can be freely accessed by the public to the total neighbourhood area.[72]

Coastal access will be calculated using the shortest street network distance from the residential address to the closest access point.

Distance to school: participant-drawn routes to school will be used to calculate the distance to school. In the likelihood that these data will not be collected for all participants, estimated distance to school will also be generated using the shortest street network distance from home to school.[73]

Food outlet data will be collected from local authorities and classification protocols of Vandevijvere *et al*[74] applied to determine density of food outlets deemed healthy, partly healthy and unhealthy.

DATA ANALYSIS

Initial statistical analyses will be primarily descriptive presenting frequencies, medians and IQRs or means and SDs where applicable. Distributions of outcome variables will be examined to determine the most appropriate statistical model for the multivariate modelling. Multilevel general linear, Poisson, or logistic modelling (depending on appropriate outcome distributions), will be used to examine associations between neighbourhood built environment and children's outcome measures (physical activity, active travel and independent mobility) at both individual and neighbourhood levels. The outcome variables will be adjusted for demographic (including socioeconomic) variables, weather and where relevant, nutritional measures. Models will include intraneighbourhood correlation (schools and classes) as random effects. A best subset method will be used for model selection and diagnostics testing will determine if model assumptions are adequately met. All analyses will be run in SAS V.9.2.

DISCUSSION

Built environments that promote sustainable increases in physical activity in children (as well as adults) have the potential to improve population health and reduce chronic disease in the short and long terms. This study is the first to use online interactive mapping methods such as softGIS to investigate how neighbourhood built environment features are associated with independent mobility, active transport and physical activity of young children aged 9–12 years. Use of this emerging methodology facilitates a greater understanding of these relationships by capturing detailed information about child-specific neighbourhood destinations visited, as well as travel modes to, and perceptions of, these features. A child-centred approach enables the collection of information about neighbourhood features and destinations and travel and activity behaviours that would not be captured using traditional adult or researcher-centred methods. Alongside this detailed examination of neighbourhood environments, objective measures of physical activity and body size, as well as data collected about the family and school contexts, will provide an in-depth understanding of relationships between neighbourhoods and health from a socioecological perspective. Results will be disseminated to participants, local government agencies and urban planners, and through conventional academic avenues (presentations at scientific conferences, peer-reviewed academic journal publications).

We anticipate that children who reside in neighbourhoods considered highly walkable (ie, characterised by higher street connectivity, dwelling density, destination accessibility and streetscape safety and aesthetics) will be more physically active, accumulate more independent mobility and active travel, and be more likely to have a healthy body size. Findings will provide evidence needed to inform the design of urban areas as cities continue to intensify internationally, and to inform policy on redevelopment of established urban areas. It is vital that children are provided with opportunities to develop healthy mobility and physical activity patterns for their current and future well-being. Well-designed built environments that take children's needs into consideration may be fundamental to encouraging these health-promoting behaviours.

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