Is having a 20-minute neighbourhood associated with eating out behaviours and takeaway home delivery? A cross-sectional analysis of ProjectPLAN

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Abstract

Background: Through improved service provision and accessibility, 20-min neighbourhoods (20MNs) aim to enable people to meet most of their daily (non-work) needs within 20 min from home. Associations between 20MNs and food practices remain unknown. This study examines links with the frequency and location of eating out behaviours as well as the frequency of home food delivery.

Methods: This cross-sectional study used data from 769 adults from the Places and Locations for Activity and Nutrition study (ProjectPLAN) conducted in Melbourne and Adelaide, Australia, between 2018 and 2019. Outcomes were 1) visit frequency to i) cafés, ii) restaurants, bars or bistros, iii) major chain fast food outlets and iv) takeaway outlets to purchase food; 2) total number of different types of out-of-home food outlets visited; 3) use frequency of home food delivery services; 4) distance from home to the most frequented out-of-home food outlets. Exposure was whether participants had a 20MN (areas with high service/amenity provision) or a non-20MN (areas with low service/amenity provision). Ordinal regression models were fitted for the frequency outcomes. Poisson regression models were fitted for the number of different outlet types. Linear and spatial regression models were fitted for the distance outcomes.

Results: Results suggested no differences in frequency of visitations to out-of-home food outlets and use of food delivery services between those with a 20MN and those with a non-20MN. Yet, those with a 20MN were more likely to use a greater number of different types of outlets on a weekly basis. Where a regular eating out location was reported, it was nearer to home for those with a 20MN.

Conclusions: This study provides evidence supportive of 20MNs potentially facilitating more localised food practices, however, 20MNs may also encourage greater cumulative frequency of meals out across a variety of out-of-home food providers.

Keywords: Food practices, Out-of-home foods, Neighbourhood, 20-min neighbourhood, Australia

Background

The recent rapid increase in the size of urban populations worldwide has necessitated a focus on creating liveable cities [1, 2]. Various cities across the world have developed plans in response to population growth (e.g. [3–5]),. One concept increasingly included in urban plans is that of compact city designs branded as 20-min
neighbourhoods (20MNs) [3, 6]. This concept which originated in Portland (United States (US)) holds local accessibility of services and amenities as key to neighbour- bourhood liveability [3]. Interest in 20MNs has grown in recent years, with cities such as Melbourne (Australia) [6, 7], Paris (France) [5], Edinburgh, (United Kingdom) [8], and Tempe (US) [4] incorporating similar concepts in their urban plans.

In Melbourne, the creation of 20MNs was put forward as a key part of a strategy to accommodate urban growth and ensure liveable neighbourhoods [6, 7]. Through improved service provision and accessibility, 20MNs aim to enable people to meet most of their daily (non-work-related) needs within 20 min from home. Whilst untested environmental, social, economic, and health benefits have been projected [7], it is also unknown whether benefits of having a 20MN expand to behaviours such as food practices.

Out-of-home foods have become a main component of diets in many high-income countries [9, 10], including Australia [11]. For example, recent food expenditure and food habit trends show that eating out-of-home foods is on the rise in Australia [11]. Home-prepared foods have been partially replaced by foods prepared away from home such as fast food and takeaway meals [12]. These patterns are reflected in household expenditure trends, with Australian households spending 34% of their food budget on out-of-home foods in 2015–16 compared to 27.5% in 2003–04 [11]. Out-of-home foods tend to be more energy-dense and nutrient-poor than foods prepared at home, potentially contributing to poorer diet quality [13]. Overall, Australia’s nutritional health status is poor, with most of the population generally failing to meet dietary guidelines [14]. Other high-income countries follow similar diet quality trends [15, 16]. Understanding drivers of out-of-home food consumption is therefore essential to help improve population diet, particularly when poorer diets are key contributors to chronic conditions such as obesity, type II diabetes and cardiovascular disease [17, 18].

When considering the evidence on the association between neighbourhood factors (such as food accessibility) and food practices, recent reviews have highlighted inconsistencies in findings [19–22]. Studies have mostly focused on the purchasing and consumption of foods from a limited category of food outlet types (e.g., fast food outlets) and few have examined food purchasing locations [23–28]. Ignoring where people buy foods means existing evidence does not reflect how people engage with their neighbourhood. Failing to capture actual interactions (i.e., what, where and how often food is purchased) limits our ability to draw links between neighbourhood and food practices, and, in turn, limits our ability to fully assess implications for health. Besides these practices which require engagement with the neighbourhood, there are additional food behaviours that people can do from home such as ordering food delivery, particularly with the surge in home food delivery options [29–33] that have increased the availability and accessibility of food options including those further away from home. A deeper understanding of how home food delivery services are used in relation to people’s residential neighbourhood is necessary to avoid misrepresenting associations between neighbourhoods and out-of-home food purchasing frequency. Further highlighting the importance of investigating the use of home food delivery options are concerns for public health nutrition [32], with studies indicating (online) food delivery options are mostly unhealthy [29, 34].

This study examines associations between 20MNs and the frequency and location of eating out behaviours as well as the frequency of home food delivery in Melbourne where the 20MN concept has been adopted and in Adela- ide, a smaller, less densely populated Australian city, where similar compact and walkable neighbourhoods are proposed in urban plans [35]. We hypothesise that those with a 20MN less frequently visit fast food and takeaway outlets due to the availability of alternative (fresh food for preparation at home) options [36] but more often visit cafés and restaurants which allow for opportunities for social interactions [37, 38]. We also hypothesise that those with a non-20MN more frequently order home delivery for takeaway foods, since those with a non-20MN may have reduced access to food outlets within walkable distances, limiting opportunities to easily visit food outlets or pick up takeaway. Complementary to this, we expect those with a 20MN and frequently visiting out-of-home food outlets to do so closer to home compared to those with a non-20MN.

Methods

Recruitment

This cross-sectional study used data from the Places and Locations for Activity and Nutrition study (ProjectPLAN), conducted between October 2018 and May 2019 among adults living in Melbourne and Adelaide, Australia. ProjectPLAN was designed to investigate the benefits of having a 20MN on physical activity and food behaviours. Ethics approval was obtained from the Deakin University Human Research Ethics Committee (HEAG-H 168_2017).

Participant recruitment

Participants were randomly sampled from within three strata: city (Melbourne or Adelaide), neighbourhood status (20MN or non-20MN, see definition below) and
neighbourhood socioeconomic status (SES) (low or high), only considering address points within residential Mesh Blocks (which are the smallest geographical areas defined by the Australian Bureau of Statistics (ABS)) to reduce mails out to non-residential addresses. In each city, address points with a 20MN or non-20MN were considered for sampling if they had either low or high neighbourhood SES. Neighbourhood SES was based on the 2016 ABS Socio-Economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) [39]. The IRSAD summarises information about the economic and social conditions of people and households within an area, including both relative advantage and disadvantage measures, based on information from the Australian census, including income and occupation [40]. Low SES areas were based on the Statistical Areas level 1 (SA1) SEIFA IRSAD decile 1, 2 or 3 that had to be within larger statistical areas (SA2s) of decile 1, 2 or 3. SA1s within SA2 boundaries were extracted to represent small areas of low SES within a larger community that also had low SES. High SES was classified as SA1s with a SEIFA IRSAD decile of 8, 9 or 10 within an SA2 of decile 8, 9 or 10 [40].

A random selection of households within the chosen areas were invited by mail with an invitation letter including a URL and unique password to access the survey. When accessing the survey, participants were provided with a Plain Language Statement and consent form. Separate surveys were conducted for the food and physical activity behaviours. An adult (aged \( \geq \) 18 years) responsible for the majority of food shopping for the household was asked to complete the food behaviours survey.

Measures

Outcomes

The study examined 1) the usual frequency of visits to each of i) cafés, ii) restaurants, bars or bistro, iii) major chain fast food outlets such as McDonald’s, KFC, Subway, Domino’s (representing chain brand and mostly quick serve options) and iv) other (mostly independent) takeaway outlets such as sushi, Thai, Mexican, fish and chips to purchase food (responses coded: never or less than once every 2 weeks, once every 2 weeks, at least once per week); 2) the total number of different types of food outlets (cafés, restaurants/bars/bistros, major chain fast food outlets, other takeaway outlets) usually frequented at least once per week (range: 0–4); 3) the usual frequency of takeaway home deliveries (coded: never or less than once every 2 weeks, once every 2 weeks, at least once per week); and 4) the distance from home to the most frequently used i) café, ii) restaurant, bar or bistro, iii) major chain fast food outlet, and iv) takeaway outlet. Distance outcomes were only captured for participants who frequented an outlet at least once every 2 weeks and who provided details of the most frequently visited outlet. Participants were asked to provide the name of the outlet as well as the suburb and street name or nearest intersection or landmark for this food outlet. Full addresses were obtained using Google Maps and the X-Y coordinates were extracted. Participant home addresses were mapped and the shortest road network distance between the home address and the outlet was calculated for each participant, using the osrtime user-written command in Stata [41]. This command calculates the distance between two points based on latitude and longitude data, using the Open Source Routing Machine (OSRM) and OpenStreetMap [41]. Distances greater than 40km were deemed to be outliers and excluded from the analysis for each outcome.

Exposure

The exposure was whether the participant had a 20MN or a non-20MN. Twenty-minute neighbourhoods were areas that had access to a select list of services and amenities grouped within five domains: 1) healthy food (a large supermarket within a 1.5 km pedestrian network distance from home OR a smaller supermarket AND greengrocer (i.e. fruit and vegetable outlet/market) within a 1.5 km pedestrian network distance from home); 2) recreational resources (a gym within a 1.5 km pedestrian network distance from home); 3) community resources (a primary school AND general practitioner (GP) AND pharmacy AND library AND post office AND café within a 1.5 km pedestrian network distance from home); 4) public open space (access to public open space within 400 m pedestrian network distance from home AND \( \geq \) 8ha of public open space within 1 km from home); and 5) public transport (Melbourne within 5 km of GPO (General Post Office): a bus stop within a 400 m pedestrian network distance from home OR a tram stop within a 600 m pedestrian network distance from home OR a train station within an 800 m pedestrian network distance from home; Melbourne further than 5 km from the GPO: a train station within an 800 m pedestrian network distance from home AND either a bus stop within a 400 m pedestrian network distance from home OR a tram stop within a 600 m pedestrian network distance from home OR a train station within an 800 m pedestrian network distance from home AND a train station within an 800 m pedestrian network distance from home; Adelaide: a bus or O-Bahn stop within a 400 m pedestrian network distance from home OR a tram stop within a 600 m pedestrian network distance from home; and Non-20MN's had fewer than five of the individual services and amenities in Melbourne and fewer than four of the individual services and amenities in Adelaide due to the different public transport measures used across.
the two cities. Full details of the operationalisation of the 20MN have been published elsewhere [42].

Other covariates
Age (years), gender (male, female), presence of children in the household (no children, presence of at least one child < 4 years, only children aged 5 to 17 years), highest qualification (less than university, university), ability to manage on household income (very difficult/difficult, just getting by, comfortable/very comfortable), neighbourhood SES (low, high), and neighbourhood self-selection (not within 20MN/in 20MN but not important, in 20MN and important) considered as potential confounders.

Neighbourhood self-selection relates to people choosing to live in a neighbourhood with facilities and resources that accommodate their preferred lifestyles [43]. Adjusting for neighbourhood self-selection can therefore help distinguish the impact of neighbourhood features on behaviours from the choice to live near features facilitating those preferred behaviours [43]. Choosing to live in a neighbourhood that met their everyday (non-work) needs within a 20-min walk was used as a measure of neighbourhood self-selection in this study.

Statistical analysis
Ordinal regression models were fitted for each frequency outcome. Likelihood ratio tests were used to compare constrained (i.e., assuming proportional odds) and unconstrained models to verify the proportional odds assumption. Minimally adjusted models included only the stratification variable neighbourhood SES. Adjusted models included all potential confounders. Models with and without adjustment for neighbourhood self-selection were fitted to examine the impact of self-selection adjustment on findings. Poisson regression models were fitted for the number of different outlet types frequented at least once per week.

A complete case analysis was conducted assuming data were Missing Completely At Random (MCAR). Sample characteristics for the complete case sample appeared to be representative of the original sample (see Additional file 1). Sample sizes for each outcome are shown in Additional file 2.

Additionally, linear regression models were fitted to examine differences in mean distance travelled to each food outlet type by 20MN, adjusting for neighbourhood SES. Adjusted models included age, gender and neighbourhood self-selection. Distances were log-transformed to deal with the skewed distributions and coefficients and confidence intervals were exponentiated to obtain the geometric mean ratio (GMR).

Means are calculated as the $n^{th}$ root of the product of $n$ numbers (e.g., the geometric mean of the two numbers 9 and 4 is the square root of 36 [i.e., $\sqrt{(9 \times 4)}$]). Geometric means are a robust way of assessing the central tendency of a data set when dealing with skewed data. Fitting a linear regression to an untransformed outcome provides estimates of the arithmetic mean and differences in arithmetic means. However, when an outcome is log-transformed to deal with the skewed nature of the distribution, the exponentiated coefficients are estimated geometric means and GMRs. As with odds or risk ratios, the null value for a GMR is 1; values above 1 indicate a percentage increase as the exposure variable increases (e.g., a GMR of 1.12 would indicate a 12% increase with each unit increase in the continuous exposure variable), while values less than 1 indicate a percentage decrease (e.g., a GMR of 0.75 would indicate a 25% decrease with each unit increase in the continuous exposure variable). The final sample sizes for each outcome are shown in Additional file 3.

Distance travelled was assumed to be potentially more correlated for participants residing closer to one another. Therefore, an inverse distance matrix was created using participants’ home address in each city and the Moran’s I test [44] was used to test for evidence of global residual spatial autocorrelation in the adjusted models. Moran’s I is the most commonly used measure of spatial autocorrelation, providing a measure of how related observations are (i.e., model residuals in this context) based on the location at which they are measured. It is a measure of correlation which ranges from values of $-1$ which indicates negative spatial autocorrelation or complete spatial dispersion to 1 indicating high positive spatial autocorrelation. A value of 0 indicates complete spatial randomness (perfect dispersion). The Moran’s I test statistic (i.e., the estimated spatial autocorrelation) is assumed to follow a $X^2$ distribution with 1 degree of freedom in the Moran’s I test. This was conducted with Stata command estat moran. Where there was evidence of residual spatial autocorrelation, spatial autoregressive models were fitted with Stata command spregress to include spatially lagged errors using the inverse distance matrix.

All analyses were conducted separately for each city using Stata version 16.0.

Results
Descriptive characteristics
In total, 769 participants completed the food survey (Melbourne = 358; Adelaide = 411, see Additional file 2). Of these, 306 (85.5%) from Melbourne and 374 (91.0%) from Adelaide were included in the complete case analysis. Sample characteristics are detailed in Table 1.
Table 1: Descriptive characteristics of the participants by city and 20MN status (N=680)

|                          | Overall | 20-min neighbourhood | Non-20-min neighbourhood | Overall | 20-min neighbourhood | Non-20-min neighbourhood |
|--------------------------|---------|----------------------|---------------------------|---------|----------------------|---------------------------|
|                          | Melbourne | Adelaide | Melbourne | Adelaide | Melbourne | Adelaide | Melbourne | Adelaide | Melbourne | Adelaide | Melbourne | Adelaide |
| N                        | 306      | 136       | 170          | 374      | 198          | 176          |
| Frequency of visits to cafes |         |           |             |          |             |             |
| Less than once per fortnight | 118 (38.6%) | 41 (30.1%) | 77 (45.3%) | 179 (47.9%) | 84 (42.4%) | 95 (54.0%) |
| Once per fortnight          | 40 (1.3%) | 16 (11.8%) | 24 (14.1%) | 49 (13.1%) | 27 (13.6%) | 22 (12.5%) |
| At least once per week       | 148 (48.4%) | 79 (58.1%) | 69 (40.6%) | 146 (39.0%) | 87 (43.9%) | 59 (33.5%) |
| Frequency of visits to restaurants/bistros/bars |         |           |             |          |             |             |
| Less than once per fortnight | 167 (54.6%) | 61 (44.9%) | 106 (62.4%) | 217 (58.0%) | 106 (53.5%) | 111 (63.1%) |
| Once per fortnight          | 67 (21.9%) | 33 (24.3%) | 34 (20.0%) | 72 (19.3%) | 39 (19.7%) | 33 (18.8%) |
| At least once per week       | 72 (23.5%) | 42 (30.9%) | 30 (17.6%) | 85 (22.7%) | 53 (26.8%) | 32 (18.2%) |
| Frequency of visits to major chain fast food outlets |         |           |             |          |             |             |
| Less than once per fortnight | 224 (75.2%) | 101 (74.3%) | 123 (72.4%) | 292 (78.1%) | 155 (78.3%) | 137 (77.8%) |
| Once per fortnight          | 41 (13.4%) | 15 (11.0%) | 26 (15.3%) | 37 (9.9%) | 19 (9.6%) | 18 (10.2%) |
| At least once per week       | 41 (13.4%) | 20 (14.7%) | 21 (12.4%) | 45 (12.0%) | 24 (12.1%) | 21 (11.9%) |
| Frequency of visits to takeaway outlets* |         |           |             |          |             |             |
| Less than once per fortnight | 192 (62.7%) | 83 (61.0%) | 109 (64.1%) | 249 (66.8%) | 131 (66.5%) | 118 (67.0%) |
| Once per fortnight          | 54 (17.6%) | 19 (14.0%) | 35 (20.6%) | 68 (18.2%) | 32 (16.2%) | 36 (20.5%) |
| At least once per week       | 60 (19.6%) | 34 (25.0%) | 26 (15.3%) | 56 (15.0%) | 34 (17.3%) | 22 (12.5%) |
| Number of types of out-of-home outlets visited at least once per week |         |           |             |          |             |             |
| 0                         | 112 (36.6%) | 39 (28.7%) | 73 (42.9%) | 170 (45.6%) | 82 (41.6%) | 88 (50.0%) |
| 1                         | 101 (33.0%) | 45 (33.1%) | 56 (32.9%) | 106 (28.4%) | 54 (27.4%) | 52 (29.5%) |
| 2                         | 64 (20.9%) | 31 (22.8%) | 33 (19.4%) | 68 (18.2%) | 42 (21.3%) | 26 (14.8%) |
| 3                         | 24 (7.8%) | 16 (11.8%) | 8 (4.7%) | 26 (7.0%) | 16 (8.1%) | 10 (5.7%) |
| 4                         | 5 (1.6%) | 5 (3.7%) | 0 (0.0%) | 3 (0.8%) | 3 (1.5%) | 0 (0.0%) |
| Frequency of takeaway deliveries* |         |           |             |          |             |             |
| Less than once per fortnight | 265 (86.6%) | 112 (82.4%) | 153 (90.0%) | 349 (93.6%) | 183 (92.4%) | 166 (94.9%) |
| Once per fortnight          | 22 (7.2%) | 11 (8.1%) | 11 (6.5%) | 14 (3.8%) | 8 (4.0%) | 6 (3.4%) |
| At least once per week       | 19 (6.2%) | 13 (9.6%) | 6 (3.5%) | 10 (2.7%) | 7 (3.5%) | 3 (1.7%) |
| Neighbourhood SES           |         |           |             |          |             |             |
| Low SES                    | 136 (44.4%) | 50 (36.8%) | 86 (50.6%) | 158 (42.2%) | 64 (32.3%) | 94 (53.4%) |
| High SES                   | 170 (55.6%) | 86 (63.2%) | 84 (49.4%) | 216 (57.8%) | 134 (67.7%) | 82 (46.6%) |
| Age (years), mean (SD)     | 51.9 (15.8) | 49.6 (16.3) | 53.7 (15.2) | 56.5 (15.7) | 56.3 (16.5) | 56.6 (14.8) |
| Gender                     |         |           |             |          |             |             |
| Male                       | 122 (39.9%) | 54 (39.7%) | 68 (40.0%) | 145 (38.8%) | 74 (37.4%) | 71 (40.3%) |
| Female                     | 184 (60.1%) | 82 (60.3%) | 102 (60.0%) | 229 (61.2%) | 124 (62.6%) | 105 (59.7%) |
| Highest qualification      |         |           |             |          |             |             |
| Less than university       | 120 (39.2%) | 34 (25.0%) | 86 (50.6%) | 209 (55.9%) | 95 (48.0%) | 114 (64.8%) |
| University                 | 186 (60.8%) | 102 (75.0%) | 84 (49.4%) | 165 (44.1%) | 103 (52.0%) | 62 (35.2%) |
| Children in household      |         |           |             |          |             |             |
| No children                | 206 (67.3%) | 101 (74.3%) | 105 (61.8%) | 293 (78.3%) | 153 (77.3%) | 140 (79.9%) |
| At least one child < 4 yrs | 54 (17.6%) | 22 (16.2%) | 32 (18.8%) | 40 (10.7%) | 25 (12.6%) | 15 (8.3%) |
| Only child (ren) 5–17 yrs  | 46 (15.0%) | 13 (9.6%) | 33 (19.4%) | 41 (11.0%) | 20 (10.1%) | 21 (11.9%) |
| Ability to manage on income |         |           |             |          |             |             |
| Very difficult/difficult   | 30 (9.8%) | 15 (11.0%) | 15 (8.8%) | 43 (11.5%) | 21 (10.6%) | 22 (12.5%) |
| Just getting by            | 71 (23.2%) | 27 (19.9%) | 44 (25.9%) | 85 (22.7%) | 44 (22.2%) | 41 (23.3%) |
| Comfortable/Very comfortable | 205 (67.0%) | 94 (69.1%) | 111 (65.3%) | 246 (65.8%) | 133 (67.2%) | 113 (64.2%) |
| Everyday needs within 20 min and reason for moving/living here |         |           |             |          |             |             |
| No, not within 20 min/Yes but not important | 149 (48.7%) | 28 (20.6%) | 121 (71.2%) | 193 (51.6%) | 64 (32.3%) | 129 (73.3%) |
| Yes and important          | 157 (51.3%) | 108 (79.4%) | 49 (28.8%) | 181 (48.4%) | 134 (67.7%) | 47 (26.7%) |

* Note: 1 person in Adelaide had missing takeaway outlet visits and delivery frequency information.
Frequency of visits to out-of-home food outlets, number of types of weekly frequented outlets, and frequency of takeaway home deliveries

Compared with participants in a non-20MN, a higher proportion of participants with a 20MN visited cafes (Melbourne 58% vs 41%, Adelaide 44% vs 34%), restaurants/bistros/bars (Melbourne 31% vs 18%, Adelaide 27% vs 18%) and takeaway outlets (Melbourne 25% vs 15%, Adelaide 17% vs 13%) at least once per week. There was little difference in the distribution of frequency of visits to major chain fast food outlets by 20MNs vs non-20MNs for either city. A smaller proportion of participants with a 20MN did not visit any food outlet at least once per week (Melbourne 29%, Adelaide 42%) than with a non-20MN (Melbourne 43%, Adelaide 50%). Only a small proportion of participants ordered takeaway delivery at least once per week, with the majority ordering less than once per fortnight (Table 1).

Although the results from the minimally adjusted models suggested increased frequency of visitations to cafés and restaurants for participants with a 20MN compared to a non-20MN in Melbourne (Table 2), the magnitude of effect attenuated after adjustment for confounders (Cafes: odds ratio (OR) = 1.51, 95% confidence interval (CI) 0.88–2.59; Restaurants: OR = 1.19, 95% CI 0.70–2.03). There did not appear to be differences in frequency of visitation to major chain fast food outlets or takeaway outlets between 20MNs and non-20MNs in Melbourne (Table 2). In Adelaide, there was no evidence of a difference in frequency of visits between 20MNs and non-20MNs for any outlet type.

When examining the total number of different outlet types visited, participants with a 20MN were more likely to visit a greater number of types at least once per week than those with a non-20MN (Table 2), although the magnitude of the effect attenuated after adjustment for confounders (Melbourne: incidence rate ratio (IRR) = 1.29, 95% CI 0.99–1.69; Adelaide: IRR = 1.25, 95% CI 0.98–1.61). No differences in the frequency of takeaway home delivery were observed between 20MNs and non-20MNs across both cities.

Distance travelled to most visited café, restaurant/bistro/bar, major chain fast food outlet and takeaway outlet

The median distance travelled to the most frequented café was much lower for those with a 20MN (Melbourne: 1.8 km, Adelaide: 1.4 km) than those with a non-20MN (Melbourne: 4.7 km, Adelaide: 6.3 km) (Fig. 1 and Additional file 4). This was also the case for restaurants, bars or bistros and takeaway outlets. The median distance to the major chain fast food outlet most frequented was higher for participants with a 20MN (3.6 km) than a non-20MN (3.1 km) in Melbourne. However, this was not the case in Adelaide (20MN: 1.6 km, non-20MN: 4.0 km).

Results from the linear regression models suggested that those with a 20MN in Melbourne travelled between 49 and 59% shorter distances to visit their most frequented café, restaurant or takeaway than those with a non-20MN, after accounting for age, gender and self-selection (Table 3). The evidence did not suggest a difference in distance to major chain fast food outlets between 20MNs and non-20MNs (Adjusted GMR = 1.11, 95% CI 0.69–1.77).

In Adelaide, there was strong evidence that those with a 20MN travelled shorter distances to visit their most frequented outlet for all food outlet types (Table 3). Results showed participants with a 20MN travelled 69% (95% CI 56–79%) shorter distances to cafes, 65% (95% CI 45–78%) shorter distances to restaurants/bars/bistros, 67% (95% CI 46–80%) shorter distances to major chain fast food outlets and 60% (95% CI 40–74%) shorter distances to takeaway outlets.

The Moran’s I tests showed strong evidence of residual spatial autocorrelation in the models of log-distance to the most frequently visited café and takeaway in Melbourne (Table 4). The findings from spatial regression models were similar to the results from linear regression models for these outcomes (Cafes: GMR = 0.42, 95% CI 0.27–0.65, p < 0.001; Restaurants: GMR = 0.48, 95% CI 0.29–0.80, p = 0.005).

Discussion

The study examined whether 20MNs were associated with the frequency of out-of-home food outlet use, the number of different types used, the location of the most frequently visited outlets, and use of home-delivery services. Results suggested no differences between those with a 20MN and those with a non-20MN in terms of the frequency of visitations to out-of-home food outlets and use of home food delivery services. Yet, results suggest those with a 20MN were more likely to use a greater number of different types of out-of-home food outlets on a weekly basis, and for those that reported a regular out-of-home food outlet they visit, it was nearer to home for those with a 20MN. Thus, 20MNs seem to potentially facilitate more localised food practices, in this case, those related to eating out.

A greater variety of visited out-of-home food outlet types for those with a 20MN is possibly linked to the wider range of choices that are likely available in 20MNs [45]. Another explanation could also relate to some 20MNs having more compact housing to encourage higher population density. In the Australian context this often means smaller housing which may lead to less home cooking if residents feel the kitchens are restrictive.
### Table 2  Models of the frequency outcomes and the number of food outlet types visited

|                        | Melbourne $N = 306$ | Adelaide $N = 374^*$ |
|------------------------|---------------------|-----------------------|
|                        | Minimally adjusted$^1$ | Adjusted without self-selection$^2$ | Adjusted with self-selection$^3$ | Minimally adjusted$^1$ | Adjusted without self-selection$^2$ | Adjusted with self-selection$^3$ |
|                        | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value |
| **Cafes**              |                    |                      |                      |                    |                      |                      |
| 20MN                   | 1.82  (1.16, 2.83)  0.008 | 1.47  (0.91, 2.36)  0.116 | 1.51  (0.88, 2.59)  0.138 | 1.30  (0.87, 1.95)  0.200 | 1.31  (0.87, 1.97)  0.195 | 1.32  (0.85, 2.05)  0.220 |
| **Restaurants**        |                    |                      |                      |                    |                      |                      |
| 20MN                   | 1.97  (1.27, 3.06)  0.003 | 1.53  (0.95, 2.45)  0.077 | 1.19  (0.70, 2.03)  0.520 | 1.34  (0.89, 2.02)  0.161 | 1.43  (0.93, 2.19)  0.100 | 1.42  (0.89, 2.29)  0.143 |
| **Major chain fast food** |                |                      |                      |                    |                      |                      |
| 20MN                   | 1.02  (0.61, 1.70)  0.951 | 1.03  (0.58, 1.84)  0.914 | 0.86  (0.45, 1.65)  0.655 | 1.27  (0.76, 2.13)  0.355 | 1.32  (0.75, 2.32)  0.332 | 1.40  (0.77, 2.55)  0.270 |
| **Takeaway**           |                    |                      |                      |                    |                      |                      |
| 20MN                   | 1.28  (0.81, 2.02)  0.297 | 1.19  (0.71, 1.99)  0.508 | 1.30  (0.72, 2.35)  0.376 | 1.13  (0.73, 1.74)  0.580 | 1.11  (0.71, 1.74)  0.639 | 1.10  (0.68, 1.79)  0.687 |
| **Takeaway delivery**  |                    |                      |                      |                    |                      |                      |
| 20MN                   | 1.87  (0.95, 3.67)  0.069 | 1.43  (0.68, 3.03)  0.343 | 0.98  (0.42, 2.26)  0.958 | 1.84  (0.76, 4.41)  0.175 | 1.65  (0.61, 4.45)  0.321 | 2.04  (0.72, 5.82)  0.182 |
| IRR                    | 1.47  (1.18, 1.84)  0.001 | 1.35  (1.06, 1.70)  0.013 | 1.29  (0.99, 1.69)  0.058 | 1.27  (1.01, 1.59)  0.038 | 1.28  (1.02, 1.61)  0.034 | 1.25  (0.98, 1.61)  0.076 |

**Number of outlet types visited at least once per week**

|                        | Melbourne $N = 306$ | Adelaide $N = 374^*$ |
|------------------------|---------------------|-----------------------|
|                        | Minimally adjusted$^1$ | Adjusted without self-selection$^2$ | Adjusted with self-selection$^3$ | Minimally adjusted$^1$ | Adjusted without self-selection$^2$ | Adjusted with self-selection$^3$ |
|                        | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value | OR  95% CI  p-value |
| **Cafes**              |                    |                      |                      |                    |                      |                      |
| 20MN                   | 1.47  (1.18, 1.84)  0.001 | 1.35  (1.06, 1.70)  0.013 | 1.29  (0.99, 1.69)  0.058 | 1.27  (1.01, 1.59)  0.038 | 1.28  (1.02, 1.61)  0.034 | 1.25  (0.98, 1.61)  0.076 |

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*Adjusted for neighbourhood socioeconomic status

$^2$ Adjusted for neighbourhood socioeconomic status, age, gender, qualifications, children in the household, ability to manage on income

$^3$ Adjusted for neighbourhood socioeconomic status, age, gender, qualifications, children in the household, ability to manage on income, neighbourhood self-selection

$^* N = 373$ for takeaway outlets, takeaway delivery and number of outlet types in Adelaide
and the ability to host guests for meals at home is reduced [46], although home cooking was not assessed in this study.

No differences in the frequency of home delivery of takeaway foods were found. A possible explanation may relate to food delivery services being easily available and accessible regardless of neighbourhood type [29, 32]. Convenience, rather than neighbourhood factors, may be a more important driver of food delivery services usage [31, 47]. While the rapid growth of food delivery providers has driven research into these services [29, 30, 33, 34], further research is needed into the individual determinants of their use and the moderating role of the neighbourhood food environment.

Understanding how different individuals interact with their neighbourhood and where they perform food practices is crucial for building stronger evidence between exposure and use. Except for major chain fast food outlets in Melbourne where no differences were observed (perhaps owing to the high proliferation of chain fast food outlets across all areas [48]), those with a 20MN travelled shorter distances to visit their most frequented outlet, suggesting 20MNs encourage localised food purchasing and interactions with local businesses. Advantages that may stem from the localised use of these outlets are increased opportunities to socialise, build a sense of community, and support local businesses [49].

This study is strengthened by its inclusion of two different Australian cities, allowing for assessment across different contexts, enhancing our understanding of the generalisability of the results. The study is further strengthened by its assessment of multiple out-of-home food outlet types and two behaviours (i.e., visiting food outlets and ordering food delivery). Four different types of out-of-home food outlets as well as home food delivery services were examined, whereas a large majority of studies investigating the relationship between the neighbourhood environment and the use of out-of-home food outlets have mostly been limited in scope to fast food outlets [24, 45, 50–53]. The location of

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**Fig. 1** Boxplots of the distance to the most frequented food outlet by city and neighbourhood status. Legend: Sample sizes differ for each outlet as not all participants regularly visit each of these outlets. Café: Melbourne: N = 157; Adelaide: N = 175. Restaurant/bistro/bar: Melbourne: N = 98; Adelaide: N = 134. Major chain fast food outlet: Melbourne: N = 68; Adelaide: N = 74. Takeaway outlet: Melbourne: N = 94; Adelaide: N = 103.
Table 3  Models of the difference in log-distances to each food outlet

| Food Outlet | Melbourne | | Adelaide | |
|-------------|-----------|-------------------------------|-------------------------------|
|              | Minimally adjusted\(^a\) | Adjusted without self-selection\(^b\) | Adjusted with self-selection\(^c\) | Minimally adjusted\(^d\) | Adjusted without self-selection\(^b\) | Adjusted with self-selection\(^c\) |
|              | GMR | 95% CI | p-value | GMR | 95% CI | p-value | GMR | 95% CI | p-value | GMR | 95% CI | p-value |
| Cafes\(^d\) | 20MN | 0.43 | (0.30, 0.61) | < 0.001 | 0.49 | (0.31, 0.78) | 0.003 | 0.43 | (0.29, 0.62) | < 0.001 | 0.43 | (0.29, 0.62) | < 0.001 | 0.31 | (0.22, 0.43) | < 0.001 | 0.32 | (0.23, 0.44) | < 0.001 | 0.31 | (0.21, 0.44) | < 0.001 |
| Restaurants\(^e\) | 20MN | 0.44 | (0.29, 0.65) | < 0.001 | 0.41 | (0.25, 0.66) | < 0.001 | 0.42 | (0.28, 0.63) | < 0.001 | 0.41 | (0.28, 0.63) | < 0.001 | 0.31 | (0.22, 0.43) | < 0.001 | 0.31 | (0.20, 0.46) | < 0.001 | 0.35 | (0.22, 0.55) | < 0.001 |
| Major chain fast food\(^f\) | 20MN | 1.06 | (0.70, 1.62) | 0.769 | 1.11 | (0.69, 1.77) | 0.664 | 1.00 | (0.64, 1.56) | 0.990 | 0.33 | (0.21, 0.53) | < 0.001 | 0.33 | (0.20, 0.52) | < 0.001 | 0.33 | (0.20, 0.54) | < 0.001 |
| Takeaway\(^g\) | 20MN | 0.42 | (0.26, 0.68) | 0.001 | 0.51 | (0.28, 0.93) | 0.028 | 0.43 | (0.26, 0.71) | 0.001 | 0.51 | (0.28, 0.93) | 0.028 | 0.38 | (0.26, 0.55) | < 0.001 | 0.37 | (0.26, 0.54) | < 0.001 | 0.40 | (0.26, 0.60) | < 0.001 |

GMR Geometric Mean Ratio

\(^{a}\) Adjusted for neighbourhood socioeconomic status

\(^{b}\) Adjusted for neighbourhood socioeconomic status, age and gender

\(^{c}\) Adjusted for neighbourhood socioeconomic status, age, gender, neighbourhood self-selection

\(^{d}\) Melbourne: \(N = 157\); Adelaide: \(N = 175\)

\(^{e}\) Melbourne: \(N = 98\); Adelaide: \(N = 134\)

\(^{f}\) Melbourne: \(N = 68\); Adelaide: \(N = 74\)

\(^{g}\) Melbourne: \(N = 94\); Adelaide: \(N = 103\)
frequently visited outlets was collected with minimum participant burden, using the self-reported address or street intersection and calculating a network distance to this from the participant’s home address. Examin ing the location of frequented food outlets allows for a more accurate representation of neighbourhood use as it captures where the interaction with the food environment occurs (rather than assuming it is taking place in the most proximal outlets). It should be acknowledged that some sample sizes were small for sub-types of outlets examined in this exploratory analysis as some participants did not regularly visit these outlet types, limiting the statistical power. However, even with these small sample sizes almost all findings were in a consistent direction and effect estimates were of a similar magnitude. Additionally, assessment and adjustment for neighbourhood self-selection helped distinguish the impact of 20MNs on the study behavioural outcomes from the choice to live in a 20MN facilitating those preferred behaviours [43].

However, whilst we were able to examine the most frequented locations, we did not capture location of all outlets visited within a category. Future food environment studies should continue to investigate ways to assess all interactions with the food environment. As frequency of visits to out-of-home food outlets and use of home food delivery services were self-reported, social desirability bias cannot be excluded. For example, frequency of fast food outlet visits may be underreported as fast food consumption may be perceived as socially undesirable. Whilst further targeted mail outs to additional addresses within strata where initial responses were lowest were undertaken (e.g., low SES 20MN addresses), results may not be representative of the wider population.

Conclusions

This study has provided evidence as to potential links between out-of-home food behaviours and the 20MN design. More specifically, while 20MNs may facilitate more localised out-of-home food practices, they may also encourage greater cumulative frequency of meals out across a variety of food outlet types. Findings are supportive of projected benefits of having a 20MN, i.e., more localised living [7]. The study found no evidence of differences in frequency of visitations to individual out-of-home food outlet types and use of food delivery services between those with a 20MN and those with a non-20MN. More research is needed to assess whether 20MNs promote healthier living.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-022-12587-1.

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Authors’ contributions

LT led the conceptualisation of the study; KL led the statistical analysis; LO led the writing of the article with input from all authors. All authors provided critical feedback on the article drafts and approved the final manuscript.

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Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained from all the participants. Ethics
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References

1. United Nations. New Urban Agenda. In: Nations U, editor. United Nations conference on housing and sustainable urban development (Habitat III); Quito: United Nations; 2016.
2. Cities Alliance. ICLI Local governments for sustainability, United Nations environment Programme. Liveable Cities: the benefits of urban environmental planning. Washington D.C.: Cities Alliance; 2007.
3. Portland Plan. Twenty-minute neighborhoods analysis: background report and analysis area summaries. Portland: City of Portland Bureau of Planning and Sustainability, 2012.
4. Community Development Department. City of Tempe general Plan 2040. Tempe: Community Development Department, 2013.
5. Paris En Commun. Ville du 1/4h Paris. 2020. Available from: https://annehidalgo2020.com/thematique/ville-du-1-4h/
6. Department of Environment, Land, Water & Planning. Plan Melbourne 2017-2050. Brunswick: The State Of Victoria Department Of Environment, Land, Water And Planning, 2017.
7. Victoria State Government. 20-minute Neighbourhoods: creating a more liveable Melbourne. Melbourne: The State of Victoria Department of Environment, Land, Water and Planning; 2019.
8. Transport and Environment Committee. City Mobility Plan. Edinburgh: Transport and Environment Committee; 2021.
9. Adams J, Goffe L, Brown T, Lake AA, Summerbell C, White M, et al. Frequency and socio-demographic correlates of eating meals out and take-away meals at home: cross-sectional analysis of the UK national diet and nutrition survey, waves 1-4 (2008-12). Int J Behav Nutr Phys Act. 2015;12:51.
10. Saksena MJ, Okrent AM, Anekwe T, Cho C, Dicken C, Effland A, et al. America’s eating habits: food away from home. Washington D.C.: United States Department of Agriculture, 2018.
11. Hogan L. Food demand in Australia trends and issues 2018. Canberra: Australian Bureau of Agricultural and Resource Economics and Sciences; 2018.
12. Venn D, Banwell C, Dixon J. Australia’s evolving food practices: a risky mix of continuity and change. Public Health Nutr. 2017;20(14):2549–58.
13. Lachat C, Nago E, Verstraeten R, Roberfoord D, Van Camp J, Kolsteren P. Eating out of home and its association with dietary intake: a systematic review of the evidence. Obes Rev. 2012;13(4):329–46.
14. Australian Institute of Health and Welfare. Poor diet. Canberra: Australian Institute of Health and Welfare; 2019.
15. United States Department of Agriculture. Scientific report of the 2015 dietary guidelines advisory committee. Washington, DC: United States Department of Agriculture, 2015.
16. Yau A, Adams J, Monsivais P. Time trends in adherence to UK dietary recommendations and associated sociodemographic inequalities, 1986-2012: a repeated cross-sectional analysis. Eur J Clin Nutr. 2019;73(7):997–1005.
17. Alshin A, Sur PJ, Fay KA, Corney L, Ferrara G, Salama JS, et al. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the global burden of disease study 2017. Lancet. 2019;393(10184):1958–72.
18. Micha R, Shulkin ML, Penalvo JL, Khatzibedachi S, Singh GM, Rao M, et al. Etiologic effects and optimal intakes of foods and nutrients for risk of cardiovascular diseases and diabetes: systematic reviews and meta-analyses from the nutrition and chronic diseases expert group (NutiCoDE). PLoS One. 2017;12(4):e0175149.
19. Stevenson AC, Brazeau A-S, Dasgupta K, Ross NA. Evidence synthesis - Neighbourhood retail food outlet access, diet and body mass index in Canada: a systematic review. Health Promot Chronic Dis Prev Can. 2019;39(10):261–80.
20. Black C, Moon G, Baird J. Dietary inequalities: what is the evidence for the effect of the neighbourhood food environment? Health Place. 2014;27:229–42.
21. Rahmanian E, Gasevic D, Vukmirlovc I, Lear S. The association between the built environment and dietary intake - a systematic review. Asia Pac J Clin Nutr. 2014;23(2):183–96.
22. Needham C, Sacks G, Orellana L, Robinson E, Allender S, Strugnell C. A systematic review of the Australian food retail environment: characteristics, variation by geographic area, socioeconomic position and associations with diet and obesity. Obes Rev. 2020;21(2).
23. Hillier A, Cannuscio CC, Karynn A, McLaughlin J, Chilton M, Glanz K. How far do low-income parents travel to shop for food? Empirical evidence from two urban neighborhoods. Urban Geogr. 2011;32(5):712–29.
24. Kerr J, Frank L, Sallis JF, Saelens B, Glanz K, Chapman K. Predictors of trips to food destinations. Int J Behav Nutr Phys Act. 2012;9(1):58.
25. Hirsch J, Hillier A. Exploring the role of the food environment on food shopping patterns in Philadelphia, PA, USA: a Semiquantitative comparison of two matched neighborhood groups. Int J Environ Res Public Health. 2013;10(1):295–313.
26. Sohi I, Bell BA, Liu J, Batterby SE, Liese AD. Differences in food environment perceptions and spatial attributes of food shopping between residents of low and high food access areas. J Nutr Educ Behav. 2014;46(4):241–9.
27. Thornton LE, Crawford DA, Lamb KE, Ball K. Where do people purchase food? A novel approach to investigating food purchasing locations. Int J Health Geogr. 2017;16(1):1–3.
28. Wilde P, Steiner A, Ver PJ. For low-income Americans, living ≤1 mile (≤1.6 km) from the nearest supermarket is not associated with self-reported household food security. Curr Dev Nutr. 2017;1(1):e001446.
29. Poelman MP, Thornton L, Zenk SN. A cross-sectional comparison of meal delivery options in three international cities. Eur J Clin Nutr. 2020;74(10):1465–73.
30. Keeble M, Adams J, Sacks G, Vanderlee L, White CM, Hammond D, et al. Use of online food delivery services to order food prepared away-from-home and associated Sociodemographic characteristics: a cross-sectional, multi-country analysis. Int J Environ Res Public Health. 2020;17(14):5190.
31. Statista. Online Food Delivery Report 2020. New York: Statista; 2020. Available from: https://www.statista.com/study/40457/food-delivery/ [cited 20 Nov 2020]
32. Bates S, Reeve B, Trevena H. A narrative review of online food delivery in Australia: challenges and opportunities for public health nutrition policy. Public Health Nutr. 2020;1–11.
33. Pinho MGM, Mackenbach JD, Den Braver NR, Reulens JJW, Brug J, Lakerveld J. Recent changes in the Dutch foodscape: socioeconomic and urban-rural differences. Int J Behav Nutr Phys Act. 2020;17(1):1.
34. Partridge SR, Gibson AA, Roy R, Malloy JA, Raeside R, Jia SS, et al. Junk food on demand: a cross-sectional analysis of the nutritional quality of popular online food delivery outlets in Australia and New Zealand. Nutrients. 2020;12(10):3107.
35. Government of South Australia, Department of Planning, Transport and Infrastructure. The 30-Year Plan for Greater Adelaide 2017 Update. Adelaide: Government of South Australia, Department of Planning, Transport and Infrastructure, 2017.
36. Thornton LE, Kavanagh A-M. Association between fast food purchasing and the local food environment. Nutr Diabetes. 2012;2(12):e53.
37. Gardiner PJ. Natural neighborhood networks — important social networks in the lives of older adults aging in place. J Aging Stud. 2011;25(3):263–71.
38. Hickman P. "Third places" and social interaction in deprived neighbour-
hoods in Great Britain. J Housing Built Environ. 2013;28(2):221–36.
39. Australian Bureau of Statistics. Socio-Economic Indexes for Areas 2018. 
Available from: https://www.abs.gov.au/websitedbs/censushome.nsf/
home/soifa. [cited 12 July 2021]
40. Australian Bureau of Statistics. IRSAD 2018. Available from: https://
www.abs.gov.au/ausstats/abs@.nsf/Lookup/2333.0.55.001~2016~Main%20Features~IRSAD~20. [cited 31 Oct 2021]
41. Huber S, Rust C. Calculate travel time and distance with OpenStreet-
Map data using the open source routing machine (OSRM). Stata J. 
2016;16(2):416–23.
42. Thornton LE, Schroers R, Lamb KE, Daniel M, Ball K, Chaix B, Kestens Y, Best 
K, Oostenbach L, Coffee NT. Operationalising the 20-minute neighbour-
hood. Int J Behav Nutr Phys Act. https://doi.org/10.1186/s12966-021-
01243-3. (Accepted for publication).
43. Lamb KE, Thornton LE, King TL, Ball K, White SR, Bentley R, et al. Methods 
for accounting for neighbourhood self-selection in physical activity and 
dietary behaviour research: a systematic review. Int J Behav Nutr Phys Act. 
2020;17(1).
44. Moran PAP. Notes on continuous stochastic phenomena. Biometrika. 
1950;37(1/2):17.
45. Thornton LE, Bentley RJ, Kavanagh AM. Fast food purchasing and access 
to fast food restaurants: a multilevel analysis of VicLANES. Int J Behav Nutr 
Phys Act. 2009;6(1):28.
46. Thornton L, Rich S, Johnson L, Horne R, Andrews F. Pie in the sky: explor-
ing food practices amongst those living in apartments within Melbourne, 
Australia. Cities Health. 2020:1–4.
47. Passport. Online, mobile and delivery: three trends that are changing the 
way we dine out. London: Euromonitor International; 2016.
48. Needham C, Orellana L, Allender S, Sacks G, Blake MR, Strugnell C. Food 
retail environments in greater Melbourne 2008–2016: longitudinal analy-
sis of Intra-City variation in density and healthiness of food outlets. Int J 
Environ Res Public Health. 2020;17(4):1321.
49. Angelopoulos S, Boyml J, De Silva A. Identifying and valuing the eco-

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