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1 **Socioeconomic differences in associations between living in a 20-minute neighbourhood**
2 **and diet, physical activity and self-rated health: cross-sectional findings from**
3 **ProjectPLAN**

4

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19

20

21 **ABSTRACT**

22 The 20-minute neighbourhood (20MN) concept aims to enable residents to meet daily needs
23 using resources within a 20-minute trip from home noting that there is no single definition of
24 what services and amenities are required for daily needs nor what modes of transport
25 constitute a 20 minute trip. Whether 20MNs promote better health and whether associations
26 differ by socio-economic status (SES) is unknown. Using cross-sectional data from adults
27 randomly sampled in 2018-19 from Melbourne or Adelaide, Australia, we examined whether
28 associations between neighbourhood type (20MN/non-20MN) and diet, physical activity or
29 self-rated health vary according to individual- or area-level SES. We found no consistent
30 patterns of interactions. The results do not consistently support the often assumed belief that
31 20MNs support more healthful behaviour and that these relationships vary by SES.

32

33 **KEYWORDS**

34 Built environment, 20-minute neighbourhood, physical activity, eating behaviours

35

36 **ABBREVIATIONS**

37 ProjectPLAN: Places and Locations for Activity and Nutrition study; 20MN: 20-minute
38 neighbourhood; SES: socioeconomic status; IRSAD: Index of Relative Socio-economic
39 Advantage and Disadvantage; BMI: body mass index; CI: Confidence Interval; IQR:
40 interquartile range.

41

42 **INTRODUCTION**

43 Diet and physical activity behaviours are key contributors to health and wellbeing (Afshin et
44 al., 2019, Murray et al., 2020, Lee et al., 2012). However, even within high-income countries
45 such as Australia, many people fail to achieve recommended daily levels of fruit and

46 vegetable consumption or physical activity (Leme et al., 2021, Guthold et al., 2018,
47 Australian Institute of Health and Welfare, 2018). Individual-level factors such as age, sex
48 and education are known to be associated with dietary and physical activity behaviours
49 (Marques et al., 2015, Alkerwi et al., 2015, Thorpe et al., 2019, Li et al., 2020). Recognising
50 that individual-choices are influenced by environmental exposures, health-promoting built
51 environments have been a key focus of recent population-level policy responses (Pineo et al.,
52 2018). This includes improving access to facilities that encourage healthful behaviours, such
53 as parks (Sallis et al., 2016) and outlets selling (fresh) healthful food (Trapp et al., 2015,
54 Moore et al., 2008).

55 A number of systematic reviews have reported links between the built environment and diet
56 and physical activity behaviours, although the underlying evidence is uneven rather than
57 wholly consistent (Ige-Elegbede et al., 2020, Rahmanian et al., 2014, Smith et al., 2017).
58 Findings have also been inconsistent when examining self-rated health, although there is less
59 research on built environment effects on self-rated health (Spring, 2018, McCormack et al.,
60 2019). In the US, long-term exposure to environments with low levels of service provision
61 (low access to supermarkets, recreational facilities, health services, residential care facilities,
62 senior services) or potentially health damaging environments (high access to liquor stores,
63 pawn shops and fast-food outlets) was associated with a higher risk of poor self-rated health
64 (Spring, 2018). However, in Canada, research found little evidence of a relationship between
65 access to community resources and self-rated health (McCormack et al., 2019).

66 The importance of creating local built environments that support health and well-being,
67 whilst ensuring that underlying socioeconomic disparities do not increase, was a key part of
68 the Victorian Government initiative named 'Plan Melbourne' (State of Victoria Department
69 of Environment, 2017, State of Victoria Department of Transport, 2014, State of Victoria
70 Department of Environment, 2019). The 20-minute neighbourhood (20MN) concept was

71 posited as a key feature of Plan Melbourne, with its aim to provide residents the ability to
72 meet most of their everyday needs within a 20-minute trip from home. Over subsequent,
73 multiple iterations of this document, the definition of how a 20-minute trip ostensibly
74 supports health continued to evolve (c.f. (Thornton et al., 2022)). The 2015 version (State of
75 Victoria Department of Environment, 2015) stated the 20-minute trip was limited to
76 “primarily within a 20-minute walk” with an estimated distance of 1 to 1.5km. In the more
77 recent 2019 update (State of Victoria Department of Environment, 2019), it is stated “within a
78 20-minute walk from home with access to safe cycling and local transport options” and “this
79 20-minute journey represents an 800m walk from home to a destination, and back again”.

80 These statements highlight that, for Melbourne, whether intentionally or unintentionally,
81 walking retains a core place as the chief envisioned mode of transport and that a 20-minute
82 journey is conceived as reflecting a small service area. Other walkable community planning
83 concepts have been proposed in less populated urban areas in Australia, such as Adelaide.
84 Although not explicitly aiming for 20MNs, Adelaide does recognise the need for
85 infrastructure that supports walkable and connected communities (Government of South
86 Australia Department of Planning and Local Government, 2010).

87 Importantly, the Plan Melbourne policies and the ongoing narrative related to 20MNs in other
88 locations have implicitly tied the 20MN to better health, largely without supporting evidence.
89 How the field finds itself in such a position reflects the commingling of science, politics, and
90 management in the governance of urban development, confounding the process with tangled
91 motives, expectations and, ultimately, consequences (or lack thereof, of health benefits at the
92 least). Without a clear definition of the 20MN, it is impossible to assess the proposed health
93 benefits of the 20MN, and it is wrong to propagate unsubstantiated health benefits supportive
94 of the 20MN concept without defensible scientific data.

95 The project from which the current analysis derives, was constructed to evaluate some of the
96 potential health benefits of the 20MN. Doing so was made possible through an explicit
97 operationalisation of the 20MN in the Places and Locations for Activity and Nutrition study
98 (ProjectPLAN) (Thornton et al., 2022), with residents in 20MNs and non-20MNs then being
99 surveyed about their health and behaviour. Findings from this project have shown some
100 benefits to residing in a 20MN, such as more walking for transport (Contardo et al., 2022)
101 and a lower body mass index (Yang et al., 2022) despite a low consistency of findings
102 between Adelaide and Melbourne. Results have also suggested that 20MNs could encourage
103 a greater frequency of out-of-home meal consumption which may potentially be detrimental
104 to health (Oostenbach et al., 2022) as well as no benefit in terms of recreational walking
105 despite more walking for transport (Contardo et al., 2022).

106 Stepping back from the 20MN *per se*, there is evidence indicating that for local residential
107 areas, the availability of local area resources varies according to socio-economic status (SES)
108 (Daniel et al., 2009, Lamb et al., 2010, Marquet and Miralles-Guasch, 2015), and that
109 relationships between local resources and health-related behaviour vary according to SES.
110 For example, Rummo et al. (2015) found a stronger association between greater access to
111 convenience stores and lower dietary quality among those with lower individual-level income
112 (Rummo et al., 2015). Among adolescents in Spain, Molina-García et al. found that
113 associations between neighbourhood walkability and moderate-to-vigorous physical activity
114 differed by neighbourhood SES, with the highest activity occurring in more walkable
115 neighbourhoods with higher SES (Molina-García et al., 2017). In Japan, associations between
116 street density and proximity to commercial destinations and walking for exercise among
117 adults aged 20-64 years were only observed in high SES areas (Koohsari et al., 2017). In
118 Australia, Turrell et al. found higher levels of walking for transport in more disadvantaged
119 than advantaged neighbourhoods. In their mediation analysis, they found that this relationship

120 was explained to some extent by the disadvantaged neighbourhoods studied having built
121 environment infrastructure more conducive to walking, in addition to residents having lower
122 car access (Turrell et al., 2013). These findings suggest but do not specifically indicate that
123 the effect of residing in a 20MN on health and behaviour has the potential to differ according
124 to individual- or area-level SES.

125 Although ensuring access to health-promoting facilities is one way of supporting healthful
126 behaviour, less research has explored whether environmental-risk factors and environmental-
127 level health promotion efforts benefit all population segments equally. To address this gap,
128 the aims of this study were to examine whether the effect of living in a 20MN on dietary
129 behaviour, physical activity and self-rated health differed according to individual- or area-
130 level SES.

131

132 **METHODS**

133 ProjectPLAN examined the influence of living in a 20MN on diet and physical activity
134 behaviours in two Australian cities: Melbourne, Victoria and Adelaide, South Australia.

135 *Neighbourhood characteristics*

136 For this study, 20MNs were defined according to five domains with access to various
137 individual attributes required to meet the requirements for each domain (healthful food
138 [supermarkets and fruit and vegetable stores], recreational resources [gyms], community
139 resources [primary schools, general practitioners, pharmacies, libraries, post offices, cafés,],
140 public open space, and public transport access [bus, tram, train]). This aligns with the broad
141 but largely unspecified 20MN concept presented by Plan Melbourne at the conceptual phase
142 of this study (State of Victoria Department of Environment, 2017). Full details of the 20MN
143 definition used in this study are provided elsewhere (Thornton et al., 2022). In brief,

144 geospatial data for the 20-minute neighbourhood attributes were sourced from a combination
145 of government and commercial sources. A 1.5-kilometre distance pedestrian network service
146 area (to reflect the Plan Melbourne emphasis on walking) was created around each of the
147 geocoded healthful food outlets, recreational resources and community resources, while
148 accessibility to public open space and public transport were guided by Australian planning
149 guidelines recommendations (i.e., access to any public space within a short walk and access
150 to a minimum amount of greenspace within a larger area around homes). Different criteria
151 were set to meet the requirements of each domain. For example, for the healthful food
152 domain, a resident needed to have access to at least one large supermarket or at least one
153 smaller supermarket and a greengrocer. Thus, for this domain, three separate individual
154 attributes were mapped and assessed yet the domain criteria could be met through access to a
155 single attribute (i.e., a large supermarket). For community resources, access was required to
156 all six individual attributes. The final selection of 20MNs were defined as areas that
157 intersected all five domain layers (i.e., healthy food, recreational resources, community
158 resources, public open space and public transport). Non-20MNs were defined as areas with
159 five or fewer of the 11 individual attributes (e.g., library, supermarket, and bus stop only) in
160 Melbourne, otherwise four or fewer individual attributes in Adelaide. This definition of the
161 non-20MN differed slightly between cities due to differences in public transport
162 infrastructure (Thornton et al., 2022). Non-20MNs were defined and sampled to provide a
163 distinct referent for comparing to 20MNs, in the form of an extreme groups contrast. Under
164 this approach, areas with moderate levels of service provision were not sampled and
165 analysed.

166 Area-SES (low versus high) was defined using the Australian Bureau of Statistics Index of
167 Relative Socio-economic Advantage and Disadvantage (IRSAD) deciles. Deciles 1-3 of the
168 IRSAD at Statistical Areas Level 1 (small census based geographical areas) were classified as

169 low SES if they were also located within Statistical Areas Level 2 (larger census based
170 geographical areas) of deciles 1-3. This approach was adopted to ensure low SES areas
171 considered were small areas with low socioeconomic conditions within a larger community
172 that also had low socioeconomic conditions. The process was repeated for Statistical Areas
173 Level 1 and Statistical Areas Level 2 within deciles 8, 9 and 10 to represent areas with high
174 socioeconomic conditions. The rationale behind only considering deciles 1-3 (low SES) and
175 deciles 8-10 (high) was to ensure clear separation between areas defined as low or high SES.
176 This enables an assessment of participants from distinctly different SES contexts.

177 Neighbourhood type (20MN/non-20MN) and area-SES (low/high) were used in both the
178 sampling for ProjectPLAN and as covariates of interest in the study.

179 *Recruitment*

180 Stratified recruitment was conducted within 20MNs and non-20MNs in both low and high
181 SES areas from each city in 2018-2019. Household address points, sourced from routinely
182 available government data sources (Department of Environment, 2021, Government of South
183 Australia, 2021), for all study strata (Melbourne/Adelaide; 20MN/non-20MN; low/high SES)
184 were randomly selected, with residents at selected addresses mailed non-personalised
185 invitations to participate in ProjectPLAN. More letters were mailed to address points within
186 low SES areas due to lower anticipated response rates in these areas. To reduce participant
187 burden, half of the randomly selected households were sent an invitation to complete the
188 online food survey and the other half sent a link to complete the physical activity behaviour
189 survey (thus households received either the food or physical activity survey). Food survey
190 respondents were required to be the main household food purchaser while the resident aged
191 ≥ 18 years with the most recent birthday was invited to participate in the physical activity
192 survey. Self-rated health was solicited for both the food and physical activity surveys as were

193 data reflecting demographic and socioeconomic characteristics. In total, 782 participants
194 (3.7% response rate) from Melbourne and 830 participants (4.2% response rate) from
195 Adelaide completed either the food or PA survey.

196 Ethics approval was obtained from the Deakin University Human Research Ethics Committee
197 (HEAG-H 168_2017).

198 **Variables**

199 *Dietary behaviour outcomes*

200 The three dietary behaviour outcomes were: i) serves of fruit consumed per day (<1 serve/ 1
201 serve/ ≥ 2 serves), ii) serves of vegetables consumed per day (<2 serves/ 2 serves/ ≥ 3 serves),
202 iii) hot takeaway food consumption frequency (never or less than once per month/ more than
203 once per month but less than weekly/ at least once per week).

204 *Physical activity outcomes*

205 The three physical activity outcomes were: i) total transport walking time (minutes), ii) total
206 recreational walking time (minutes), and iii) number of other (non-walking) exercise
207 activities in the past week. Participants reporting no recreational or transport walking were
208 accorded zero minutes for walking outcomes.

209 For the third physical activity outcome of “other” (non-walking) physical activities, these
210 included recreational- or transport-related jogging/running, recreational- or transport-related
211 cycling, use of exercise/gym equipment, swimming, fitness class/ personal training, yoga/
212 pilates, and organised or social sport. An “Other” option was provided to account for any
213 activities not included in this list. The count of other activities (rather than time spent doing
214 such activities) was calculated for analysis as this variable aimed to capture the variety of
215 activities in which participants engaged.

216 *Self-rated health outcome*

217 Both food and physical activity survey participants responded to the question “in general,
218 how would you rate your health?”, with responses on a 5-point scale ranging from poor to
219 excellent. Response options were coded to three categories, given small cell counts (poor or
220 fair/good/very good or excellent).

221 All outcome measures were adapted from past studies such as VicLANES (King et al., 2015)
222 and READI (Thornton et al., 2015) which have both examined neighbourhoods and health in
223 the Australian context.

224 *Exposure*

225 Neighbourhood type (20MN/non-20MN).

226 *Moderators*

227 Two SES measures were considered: i) area-SES (low/high) and ii) individual-SES measured
228 by highest educational qualification obtained (up to year 12/certificate or diploma/university).

229 *Other covariates*

230 Potential confounders of apparent relationships between residing in a 20MN or not and each
231 outcome were identified using causal diagrams (see Appendix Figure 1 a-c). Age (years) and
232 gender (male/female) were considered prognostic of the outcomes. Children in the household
233 (no children/ at least one child aged ≤ 4 years /only child(ren) aged >4 years), relationship
234 status (in a relationship and living with partner, versus not living with partner/single) and
235 neighbourhood self-selection were all identified as potential confounders.

236 Neighbourhood self-selection included preference to live within a 20-minute walk of: i) a
237 supermarket (fruit and vegetable intake outcomes only), ii) everyday (non-work) needs (all
238 diet outcomes; transport walking; number of physical activities), iii) parks, beaches or open

239 space (recreational walking; number of exercise activities), or iv) recreational facilities, such
240 as gyms (number of activities). These variables were created by combining responses to two
241 survey questions. The first asked about outcomes specific to where a respondent currently
242 lives (e.g., “Within a 20-minute walk, I can reach a grocery store or supermarket”; “Overall,
243 within a 20-minute walk I can meet most of my everyday (non-work) needs”, etc.) with
244 response options of ‘yes’ or ‘no’. The second question asked which attributes present within a
245 20-minute walk (i.e., those for which the response to the first question was ‘yes’) were core
246 reasons underpinning why the respondent chose to move to or live at their current address
247 (e.g., “Within a 20-minute walk, I can reach a grocery store or supermarket”; “Overall, within
248 a 20-minute walk I can meet most of my everyday (non-work) needs”, etc.) with response
249 options ‘yes’ or ‘no’. For each of the four self-selection items, responses to these two
250 questions for each attribute were dichotomised as ‘not within a 20-minute walk, or within a
251 20-minute walk and not an important reason for living here’, or ‘within a 20-minute walk and
252 an important reason for living here’. Each item was considered separately.

253 *Statistical analysis*

254 Analyses were conducted separately for Melbourne and Adelaide as it was considered *a*
255 *priori* that the estimated effect of living in a 20MN on outcomes could differ between the two
256 cities due to differences in population density, the density of services and amenities and
257 public transport infrastructure. Ordinal regression was used to assess whether the effect of
258 residing in a 20MN differed by either SES measure for each of the diet outcomes and self-
259 rated health. Two-part models were fitted to each of the walking duration outcomes given the
260 scope of zero-inflation of observations from participants reporting no walking. Poisson
261 regression was used for analysis of the number of activities undertaken. Interactions between
262 neighbourhood type (20MN) and SES (either area-SES or individual-SES) were included in
263 each model. Models adjusted for measured prognostic and confounding variables.

264 A complete case analysis was conducted in primary analysis. Sample characteristics were
265 compared for the complete case and omitted participants. With a few exceptions, these were
266 comparable (see Appendix Table 1).

267 *Sensitivity analyses*

268 Models were fitted with and without adjustment for neighbourhood self-selection to assess its
269 impact on results. Providing estimates from both models assists understanding how estimated
270 effects differed, dependent on adjustment (Lamb et al., 2020). Additional diet and physical
271 activity outcome models were fitted, accounting for body mass index (BMI) and self-rated
272 health as potential confounders. These were omitted from the primary analyses reported here
273 as they were interpreted to be mediators. To assess sensitivity to missing data assumptions,
274 multiple imputation using chained equations was used to impute missing data. Imputation
275 models included all variables included in the adjusted models, with 20 imputed data sets
276 generated. Adjusted analyses were conducted using the imputed datasets with the findings
277 pooled using Rubin's rules and compared to the complete case analyses.

278

279 **RESULTS**

280 Complete case sample sizes were 289 (81% of the full sample) and 353 (86%) for Melbourne
281 and Adelaide food samples, and 337 (84%) and 335 (83%) for Melbourne and Adelaide
282 physical activity samples, respectively. Participant characteristics are shown in Table 1.

283 *Diet outcomes*

284 Half of dietary behaviour sample participants consumed ≥ 2 serves of fruit per day
285 (Melbourne: 52%, Adelaide: 48%) whilst over 40% consumed ≥ 3 serves of vegetables per

286 day (Melbourne: 46%, Adelaide: 42%). About a third consumed hot takeaway at least once
287 per week (Melbourne: 36%, Adelaide: 31%) (Table 1).

288 Results from models testing moderation by area-SES (Figure 1) did not indicate an
289 interaction between area-SES and neighbourhood type on diet. The patterns of findings were
290 similar for low and high SES areas in both 20MNs and non-20MNs. An anomalous exception
291 was fruit consumption in Melbourne, where in 20MNs the point estimate for the predicted
292 probability of consuming ≥ 2 serves of fruit per day was higher (although, the confidence
293 intervals (CIs) overlapped) for participants in low (0.60, 95% CI: 0.46-0.74) compared to
294 high SES areas (0.49, 95% CI: 0.37-0.60). In contrast, the opposite pattern (albeit also with
295 overlapping CIs) was observed in non-20MNs (low: 0.48, 95% CI: 0.37-0.58; high: 0.54,
296 95% CI: 0.43-0.65). However, CIs for interaction terms were wide and included the null
297 (Appendix Table 2). This finding was not observed in Adelaide (Figure 1).

298 Similarly, there was no strong support for interactions between individual-SES and
299 neighbourhood type (Figure 2). As with area-SES, the only exception was fruit consumption
300 among Melbourne participants. Within 20MNs, the predicted probability of consuming ≥ 2
301 serves of fruit per day was highest for those with a trade/certificate in 20MNs (0.75, 95% CI:
302 0.54-0.97). However, it was highest among those with university education in non-20MNs
303 (0.53, 95% CI: 0.42-0.64). Although CIs did not contain the null for some interaction terms
304 (i.e., fruit intake in Melbourne), the estimated CIs were wide (Appendix Table 2).

305 The predicted probabilities for each outcome within each SES category appeared comparable
306 for 20MN and non-20MNs in both Melbourne and Adelaide (Figures 1 and 2). Therefore, in
307 general it appears that residents of 20MNs did not have better dietary behaviours than those
308 residing in non-20MNs.

309 *Physical activity outcomes*

310 Overall, median transport walking and other non-walking exercise activities were higher for
311 Melbourne (transport walking: 60 mins/week, interquartile range (IQR): 0-85; activities: 3,
312 IQR: 2-4) compared to Adelaide (transport walking: 0 mins/week, IQR: 0-80; activities: 2,
313 IQR: 1-3) (Table 1). In contrast, median recreational walking was higher in Adelaide (120
314 mins/week, IQR: 60-200) compared to Melbourne (90 mins/week, IQR: 60-180).

315 Full modelling results are presented in Appendix Table 3, with estimated marginal means
316 from adjusted models shown in Figures 3 and 4. Considering the patterns presented in Figure
317 3, amongst the physical activity outcomes there is no apparent interaction effect between
318 neighbourhood type and area-SES. Generally, the models show higher estimated marginal
319 means for participants in high SES areas in both 20MN and non-20MN in each city, although
320 with some exceptions. For example, in Adelaide, both the marginal mean minutes of
321 recreational walking and the number of recreation physical activities per week were
322 comparable for participants in low and high SES areas in non-20MNs (low SES: 133 [95%
323 CI: 109-157] mins recreational walking, 2.3 [95% CI: 2.0-2.6] activities; high SES: 132 [95%
324 CI: 108-156] mins, 2.4 [95% CI: 2.0-2.7] activities). This was not so, however, for 20MNs
325 where recreational walking and the number of activities were greater for high SES areas (low
326 SES: 114 [95% CI: 81-147] mins, 2.1 [95% CI: 1.8-2.5] activities; high SES: 162 [95% CI:
327 133-191] mins, 3.0 [95% CI: 2.7-3.4] activities).

328 Comparing the overall patterns of results for 20MNs and non-20MNs within each city, there
329 was no apparent interaction effect between neighbourhood type and individual-SES on
330 transport walking or number of activities (Figure 4). There was some suggestion that patterns
331 for recreational walking differed for 20MN compared to non-20MNs in Melbourne, with
332 mean minutes decreasing with increasing education in 20MNs but roughly the opposite
333 pattern observed in non-20MNs. However, the CI for the lowest qualification category among
334 those with a 20MN was wide (Figure 4). Further, this pattern was not observed in Adelaide.

335 Although there were no consistent interaction effects, mean transport walking appeared to be
336 higher in 20MNs relative to non-20MNs for Melbourne but not for Adelaide (Figures 3 and
337 4). There were no other clear differences between 20MNs and non-20MNs.

338 *Self-rated health*

339 The percentages reporting poor/fair health was comparable for both Melbourne samples
340 (19%) and lower than those observed for Adelaide (food: 25%; physical activity: 27%)
341 (Table 1).

342 There did not appear to be an interaction between neighbourhood type and area-SES on self-
343 rated health (Figure 5). There was some suggestion of an interaction between neighbourhood
344 type and individual-SES. However, this was not consistent across the four samples (Figure 6).
345 For example, in the Melbourne food and the Adelaide physical activity samples, the
346 estimated predicted probability of very good/excellent health decreased with higher
347 educational qualifications in 20MNs, whereas the opposite pattern was observed in non-
348 20MNs. This is shown in the modelling results (Appendix Table 4), where interaction
349 parameters in the Melbourne food and Adelaide physical activity samples do not contain the
350 null. In contrast, the same was not apparent for the Melbourne physical activity or the
351 Adelaide food samples. There did not appear to be a difference in self-rated health by
352 neighbourhood type. However, the estimated odds of better self-rated health was consistently
353 greater for high compared to low SES areas, although such effects were less pronounced for
354 the Adelaide physical activity sample (Appendix Table 4).

355 *Sensitivity analyses*

356 Findings were very similar either with (see Adjustment 2 in Appendix Tables 2-4) or without
357 (Adjustment 1) adjustment for neighbourhood self-selection. In addition, further adjustment
358 for self-rated health and BMI (Adjustment 3 [diet and physical activity models only]) had

359 little impact. Comparisons of missing data approaches are shown in Appendix Tables 5-7.
360 Although the estimated effects differed for some models (e.g., the estimated coefficient for
361 the interaction between 20MN and area-SES was -0.24 from multiple imputation, compared
362 to 0.03 from complete case in the analysis of fruit intake for Adelaide), the study conclusions
363 were not impacted by the approach taken to deal with missing data.

364

365 **DISCUSSION**

366 Findings from ProjectPLAN provided little evidence to indicate that the effect of living in a
367 20MN on dietary behaviours, physical activity or self-rated health differed by area-level or
368 individual-SES. The implication is that residing in a 20MN does not help reduce social
369 inequalities in health behaviours and outcomes. ProjectPLAN was the first study to examine
370 the 20MN built environment exposure (noting this measure was tailored to the cities under
371 investigation and was limited to considering access within a 20-minute walk only (to align
372 with the wording in the Melbourne based planning documents) and it is not possible to
373 directly compare the findings from this analysis to other studies. Where built environment
374 and SES interactions have been considered, these have typically examined single aspects of
375 the built environment, such as availability of food outlets or walkability (Mackenbach et al.,
376 2019, Pearce et al., 2008, McInerney et al., 2016, Vogel et al., 2017, Peng and Kaza, 2020, da
377 Silva et al., 2017, Zang et al., 2022, Molina-García et al., 2019, Molina-García and Queralt,
378 2017, Molina-García et al., 2017, De Meester et al., 2012, Koohsari et al., 2017, Steinmetz-
379 Wood and Kestens, 2015, Cummins et al., 2005), whereas our 20MN measure is multi-
380 dimensional.

381 In the food environment literature, few studies have found statistically significant interaction
382 effects on dietary behaviour between SES and objectively measured access or proximity to

383 the food resources (Mackenbach et al., 2019, Pearce et al., 2008, McInerney et al., 2016,
384 Vogel et al., 2017, Peng and Kaza, 2020). However, as built environmental effects on
385 behaviour outcomes are typically of small magnitude and detecting interactions with small
386 effects requires large sample sizes, it may be that studies lack power to detect these effects.
387 Of course, previous studies have generally considered just one aspect of the local built
388 environment (i.e., the food environment) and have primarily focussed on outlets deemed
389 unhealthful (e.g., fast food stores). Our 20MN exposure, on the other hand, featuring a
390 healthful food layer consisting of access to at least one large supermarket or at least one
391 smaller supermarket and greengrocer, was not designed to capture unhealthful food
392 environments. It is possible that 20MNs, both in our study and more broadly where 20MNs
393 are considered, encompass both healthful (e.g., greengrocers), and unhealthful food options
394 (e.g., fast food outlets) as found in earlier studies from Melbourne (Thornton and Kavanagh,
395 2012). This means 20MNs may not have a wholly positive influence on dietary behaviour.

396 Interactions between SES and a variety of built environment attributes related to walkability
397 including street lighting (da Silva et al., 2017), number of overpasses (Zang et al., 2022),
398 public open space (da Silva et al., 2017), availability of physical activity facilities (da Silva et
399 al., 2017) or other commercial destinations (Koohsari et al., 2017, Steinmetz-Wood and
400 Kestens, 2015) have been considered in the physical activity literature. Street connectivity (da
401 Silva et al., 2017, Zang et al., 2022, Steinmetz-Wood and Kestens, 2015) or walkability
402 (Molina-García et al., 2019, Molina-García and Queralt, 2017, Molina-García et al., 2017, De
403 Meester et al., 2012) have most frequently been considered, and with mixed findings. Some
404 studies found little to indicate an interaction between these characteristics and SES on active
405 transport, leisure time physical activity (Molina-García et al., 2019), or active commuting to
406 school (Molina-García and Queralt, 2017). Others found weaker associations between these
407 characteristics and active transportation among residents of low SES areas (Steinmetz-Wood

408 and Kestens, 2015), as well as negative associations with walking (Zang et al., 2022) and
409 positive associations with moderate-to-vigorous physical activity (De Meester et al., 2012) in
410 low SES areas. Findings from ProjectPLAN provided little indication of interactions between
411 20MN and SES on walking for recreation, transport or the number of physical activities
412 undertaken. As with the dietary behaviour literature, prior studies of interactions between the
413 built environment and SES on physical activity have tended to examine individual
414 environmental attributes, such as street connectivity. In contrast, our 20MN measure
415 considers local access to services and resources (food outlets, recreational resources,
416 community resources), public open space and public transport. Research considering links
417 between commuting physical activity and multiple attributes of the built environment, albeit
418 considering each attribute individually (e.g., street lighting, paved streets, sidewalks, street
419 connectivity, public open space, distance to gyms/health clubs), has found little evidence of
420 an interaction with SES (da Silva et al., 2017). Therefore, our findings in ProjectPLAN are
421 largely consistent with research to date.

422 Relative to dietary and physical activity behaviours, fewer studies still have examined built
423 environment and self-rated health relationships. Those that considered the built environment
424 examined community resources (McCormack et al., 2019, Spring, 2018), walkability (Colley
425 et al., 2019), highways and grassland (Nguyen et al., 2019), and housing (Badland et al.,
426 2017). Few studies have considered interactions between the built environment and SES on
427 self-rated health (Schüle and Bolte, 2015). One study from the UK found larger estimated
428 effects between access to health services and self-rated health among those that were not
429 working compared to those who were. However, they did not find that the relationship
430 between other built environment attributes, such as access to public recreational resources
431 (i.e., swimming pools, libraries), and self-rated health differed by this measure of SES
432 (Cummins et al., 2005). Findings from ProjectPLAN were mixed but overall provided little

433 evidence of a consistent or compelling interaction effect. Given the paucity of research in this
434 area, further studies are needed to assess built environment and SES interactive effects on
435 self-rated health.

436 Findings from this study not only provide little indication of SES interaction effects but also
437 little to suggest any obvious benefit from residing in a 20MN for any of the health outcomes
438 considered, apart from transport walking in Melbourne, discussed elsewhere (Contardo et al.,
439 2022). Therefore, if replicated and found generalisable, any health benefit conveyed by living
440 in a 20MN may be specific to active transportation, a finding supporting efforts to improve
441 transportation outlet availability and access.

442 For Melbourne, the working definition of the 20MN is problematic given it ties to the idea
443 that a service or amenity must be nearby to be accessible. We note this to highlight that it is
444 not our preference to limit the definition to a time-based accessibility measure that aligns
445 with walking, but one that was necessary to align our 20MN definition to the policy narrative.
446 In Melbourne, the 20MN policy now states a “20-minute journey represents an 800m walk
447 from home to a destination, and back again” (State of Victoria Department of Environment,
448 2019). Achieving this is unfeasible in cities without a high population density. Further,
449 deemphasising other modes of transport in favour of walking limits the ability to travel
450 further in a short time and makes other areas beyond the immediate neighbourhood less
451 accessible. Thus, these restrictions go against the premise that a 20MN should make
452 accessing everyday needs easier. In Melbourne, this could be best achieved by allowing
453 people to travel further using non-car-based forms of transport (e.g., cycling, or public
454 transport), making the already well-provisioned services and amenities more accessible to
455 both high and low SES residents.

456 Currently, the proximity-centred focus on access and limitations placed on travel mode (i.e.,
457 walking) runs counter to improving accessibility and reducing urban inequalities. This current
458 policy narrative makes it difficult to fully appreciate and assess the benefits of 20MNs, and
459 claims about benefits should be downplayed prior to improvements in defining the 20MN
460 (which should be accompanied by an operationalised measure as without this it is not
461 possible to assess where they exist and the benefits of living in one).

462 Limitations apply to this study. First, this study was not *a priori* powered to detect interaction
463 effects and thus interpretation was based on examining patterns in the combined effects of
464 neighbourhood type and SES. While there were some indications of interactions, differences
465 were modest and stand to be accounted for as Type 1 errors related to the number of
466 estimates considered. Furthermore, although it would be of interest to examine the combined
467 interactive effects of both individual and area-SES and neighbourhood type on health and
468 behaviour, our modest sample sizes prevented these more complex analyses. Second, as this
469 was a cross-sectional study, it was not possible to determine temporal ordering. It is possible
470 that those who are more physically active, or who have preference for certain foods, choose
471 to live in areas with greater access to these services. Therefore, residing in a 20MN may not
472 be responsible for more healthful behaviours. While attempts were made to account for
473 neighbourhood self-selection, reverse causality remains a possibility. Third, it is often
474 assumed that the relationship between area-SES and health or behaviour may be due to the
475 quantity and quality of services available, as well as perceptions of safety (Schultz et al.,
476 2018, Evans and Kantrowitz, 2002).

477 While a strength of ProjectPLAN was the stratified sampling of low and high SES areas with
478 and without a 20MN to aid in separating the effect of built and physical environment
479 attributes from area-SES, there was no assessment of the *quality* of the attributes the
480 participants could access in this study. Quality has been shown to be an important

481 determinant of health and behaviour (Sawyer et al., 2017, Francis et al., 2012). Therefore,
482 future studies of the 20MN should aim to examine both availability and quality. Fourth, no
483 information was obtained about how much time participants spent at or near their home
484 address, relevant to determining extent of exposure to the local environment. To understand
485 how the home environment influences health and behaviour, it is important to consider
486 people's activity spaces more broadly to address potential biases introduced by ignoring
487 locations in which activities are undertaken (Perchoux et al., 2015).

488 In summary, findings from ProjectPLAN do not support the belief that health or health-
489 related behaviours associated with living in a 20MN on differ according to SES. However,
490 we did not find much indication of a difference in these behaviours between 20MN and non-
491 20MN, beyond benefits for transport walking which was equally beneficial for low *and* high
492 SES areas.

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TABLES

Table 1. Descriptive characteristics of ProjectPLAN food and physical activity samples in Melbourne and Adelaide

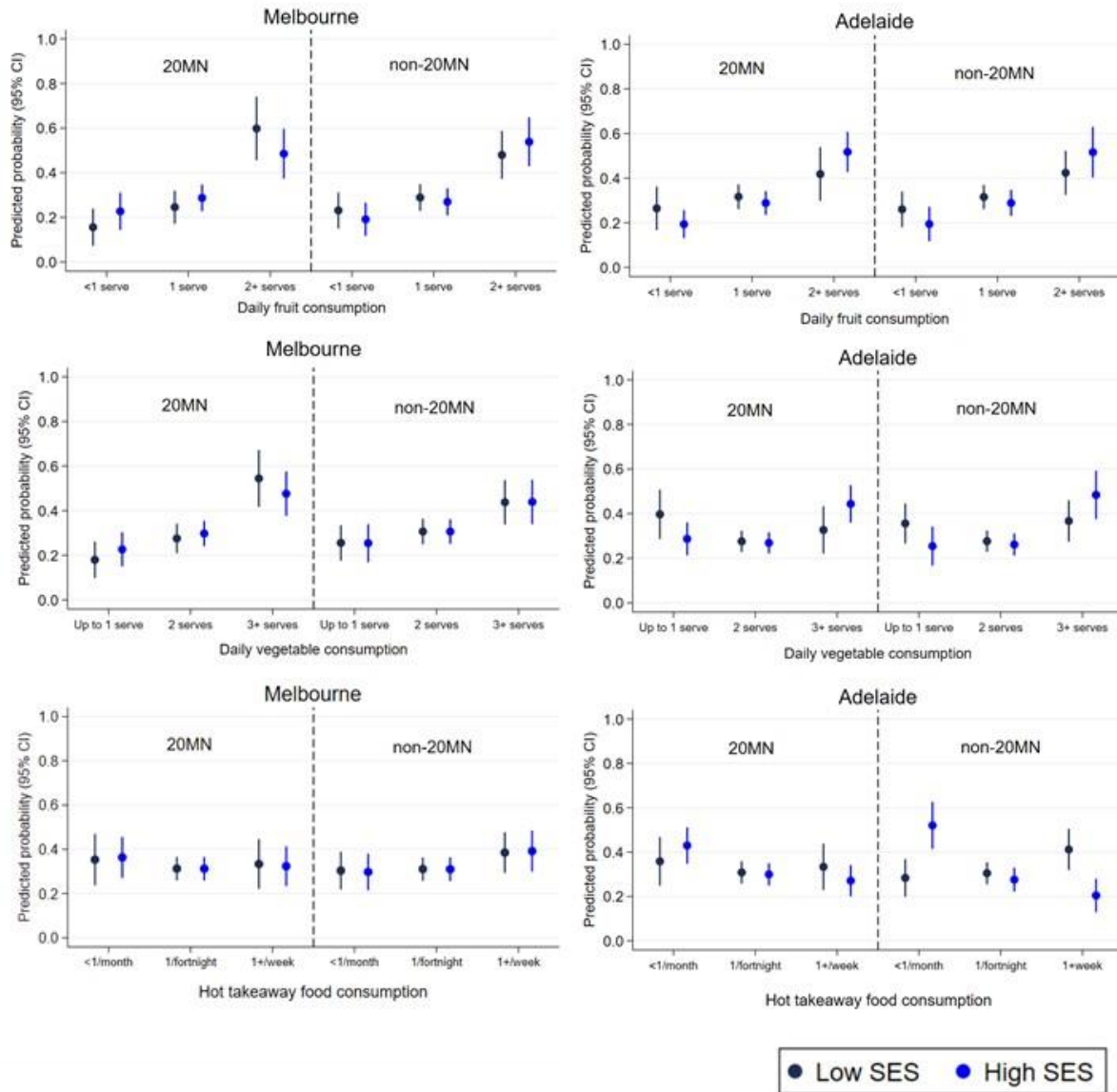
| | Melbourne Food N = 289 | Adelaide Food N = 353 | Melbourne PA N = 337 | Adelaide PA N = 335 |
|--|------------------------------|-----------------------------|----------------------------|---------------------------|
| Outcomes | | | | |
| Serves of fruit per day | | | | |
| <1 serve | 60 (20.8%) | 79 (22.4%) | n.c. | n.c. |
| 1 serve | 80 (27.7%) | 105 (29.7%) | n.c. | n.c. |
| ≥2 serves | 149 (51.6%) | 169 (47.9%) | n.c. | n.c. |
| Serves of vegetables per day | | | | |
| <2 serves | 68 (23.5%) | 112 (31.7%) | n.c. | n.c. |
| 2 serves | 87 (30.1%) | 94 (26.6%) | n.c. | n.c. |
| ≥3 serves | 134 (46.4%) | 147 (41.6%) | n.c. | n.c. |
| Frequency of hot takeaway food consumption | | | | |
| Never/less than once per month | 94 (32.6%) | 142 (40.2%) | n.c. | n.c. |
| Once every two weeks | 90 (31.3%) | 102 (28.9%) | n.c. | n.c. |
| At least once per week | 104 (36.1%) | 109 (30.9%) | n.c. | n.c. |
| Walking for transport (mins/week), median (IQR) | n.c. | n.c. | 60 (0, 85) | 0 (0, 80) |
| Walking for exercise/recreation (mins/week), median (Q1, Q3) | n.c. | n.c. | 90 (60, 180) | 120 (60, 200) |
| Number of exercise activities in past week, median (Q1, Q3) | n.c. | n.c. | 3 (2, 4) | 2 (1, 3) |
| Self-rated health | | | | |
| Poor/Fair | 56 (19.4%) | 88 (24.9%) | 65 (19.3%) | 89 (26.6%) |
| Good | 112 (38.8%) | 133 (37.7%) | 133 (39.5%) | 123 (36.7%) |
| Very Good/Excellent | 121 (41.9%) | 132 (37.4%) | 139 (41.2%) | 123 (36.7%) |
| Exposure | | | | |
| 20-minute neighbourhood | 127 (43.9%) | 191 (54.1%) | 123 (36.5%) | 170 (50.7%) |
| Moderators | | | | |
| Area-SES | | | | |
| Low SES | 127 (43.9%) | 145 (41.1%) | 142 (42.1%) | 139 (41.5%) |
| High SES | 162 (56.1%) | 208 (58.9%) | 195 (57.9%) | 196 (58.5%) |
| Highest qualification | | | | |
| Up to Year 12 | 45 (15.6%) | 78 (22.1%) | 64 (19.0%) | 68 (20.3%) |
| Trade/Certificate | 65 (22.5%) | 113 (32.0%) | 70 (20.8%) | 106 (31.6%) |
| University | 179 (61.9%) | 162 (45.9%) | 203 (60.2%) | 161 (48.1%) |
| Other covariates | | | | |
| Age (years), mean (SD) | 51.7 (15.9) | 56.4 (15.7) | 48.8 (16.6) | 57.4 (15.8) |
| Gender | | | | |
| Male | 116 (40.1%) | 138 (39.1%) | 146 (43.3%) | 146 (43.6%) |
| Female | 173 (59.9%) | 215 (60.9%) | 191 (56.7%) | 189 (56.4%) |
| Children in household | | | | |
| No children | 194 (67.1%) | 277 (78.5%) | 226 (67.1%) | 257 (76.7%) |
| Child(ren) under 4 yrs | 52 (18.0%) | 37 (10.5%) | 58 (17.2%) | 37 (11.0%) |

| | | | | |
|---|-------------|-------------|-------------|-------------|
| <i>Only child(ren) over 4 yrs</i> | 43 (14.9%) | 39 (11.0%) | 53 (15.7%) | 41 (12.2%) |
| Relationship status | | | | |
| <i>Single/Not living with partner</i> | 99 (34.3%) | 130 (36.8%) | 126 (37.4%) | 124 (37.0%) |
| <i>Living with partner</i> | 190 (65.7%) | 223 (63.2%) | 211 (62.6%) | 211 (63.0%) |
| Supermarket reason for moving/living here | | | | |
| <i>Not within 20min/not important</i> | 120 (41.5%) | 149 (42.2%) | | |
| <i>Important</i> | 169 (58.5%) | 204 (57.8%) | n.c. | n.c. |
| Everyday needs within 20 minutes reason for moving/living here | | | | |
| <i>Not within 20min/not important</i> | 130 (45.0%) | 165 (46.7%) | 182 (54.0%) | 167 (49.9%) |
| <i>Important</i> | 159 (55.0%) | 188 (53.3%) | 155 (46.0%) | 168 (50.1%) |
| Park, open space or beach reason for moving/living here | | | | |
| <i>Not within 20min/not important</i> | | | 131 (38.9%) | 124 (37.0%) |
| <i>Important</i> | n.c. | n.c. | 206 (61.1%) | 211 (63.0%) |
| Recreational facilities (e.g., gyms) reason for moving/living here | | | | |
| <i>Not within 20min/not important</i> | | | 220 (65.3%) | 247 (73.7%) |
| <i>Important</i> | n.c. | n.c. | 117 (34.7%) | 88 (26.3%) |
| Body mass index (kg/m²), mean (SD) | 25.3 (4.3) | 26.8 (5.0) | 25.7 (4.5) | 26.8 (5.0) |

ProjectPLAN: Places and Locations for Activity and Nutrition study; PA: physical activity; SES: socioeconomic status; n.c. = not collected (indicates covariates that were not measured in the sample).

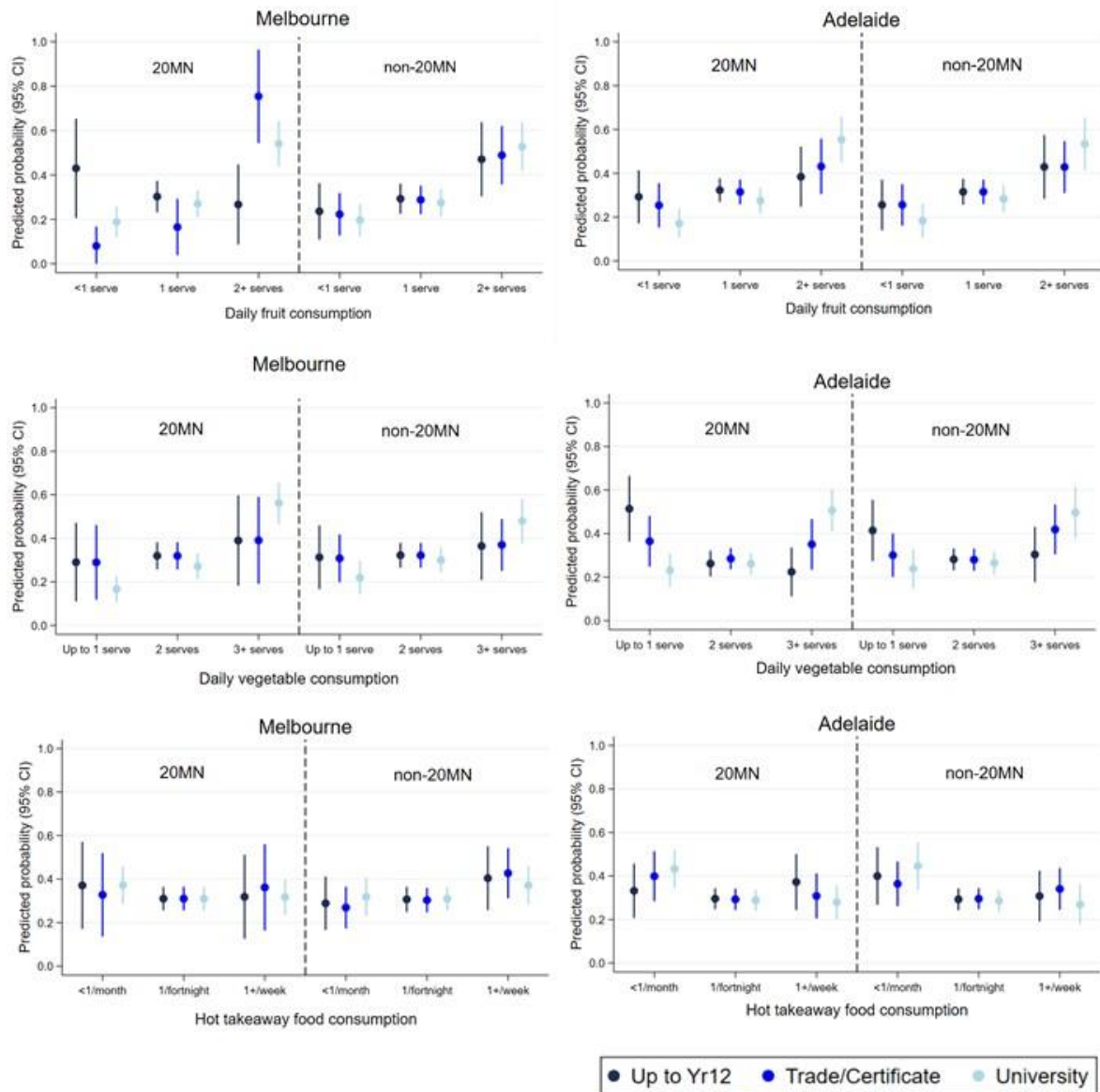
FIGURES

Figure 1. Predicted probability with 95% confidence intervals of each diet outcome by neighbourhood type and area-SES for each city from adjusted ordinal regression models.



*Hot takeaway food consumption: <1/month is Never or <1/month.

Figure 2. Predicted probability with 95% confidence intervals of each diet outcome by neighbourhood type and highest qualification for each city from adjusted ordinal regression models.



*Hot takeaway food consumption: <1/month is Never or <1/month.

Figure 3. Marginal mean with 95% confidence intervals of each physical activity outcome by neighbourhood type and area-SES for each city from adjusted two-part and Poisson regression models.

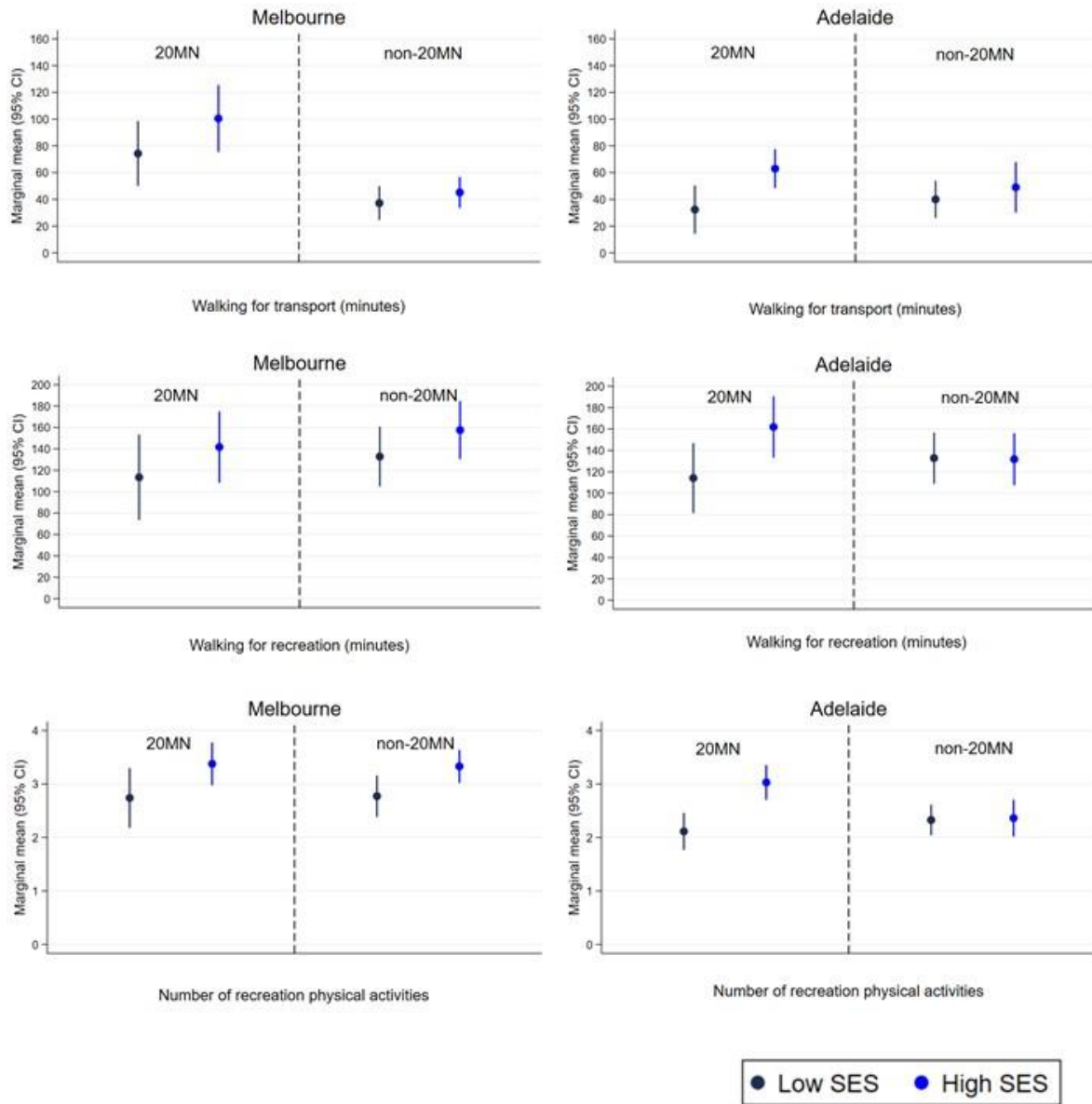


Figure 4. Marginal mean with 95% confidence intervals of each physical activity outcome by neighbourhood type and highest qualification for each city from adjusted two-part and Poisson regression models.

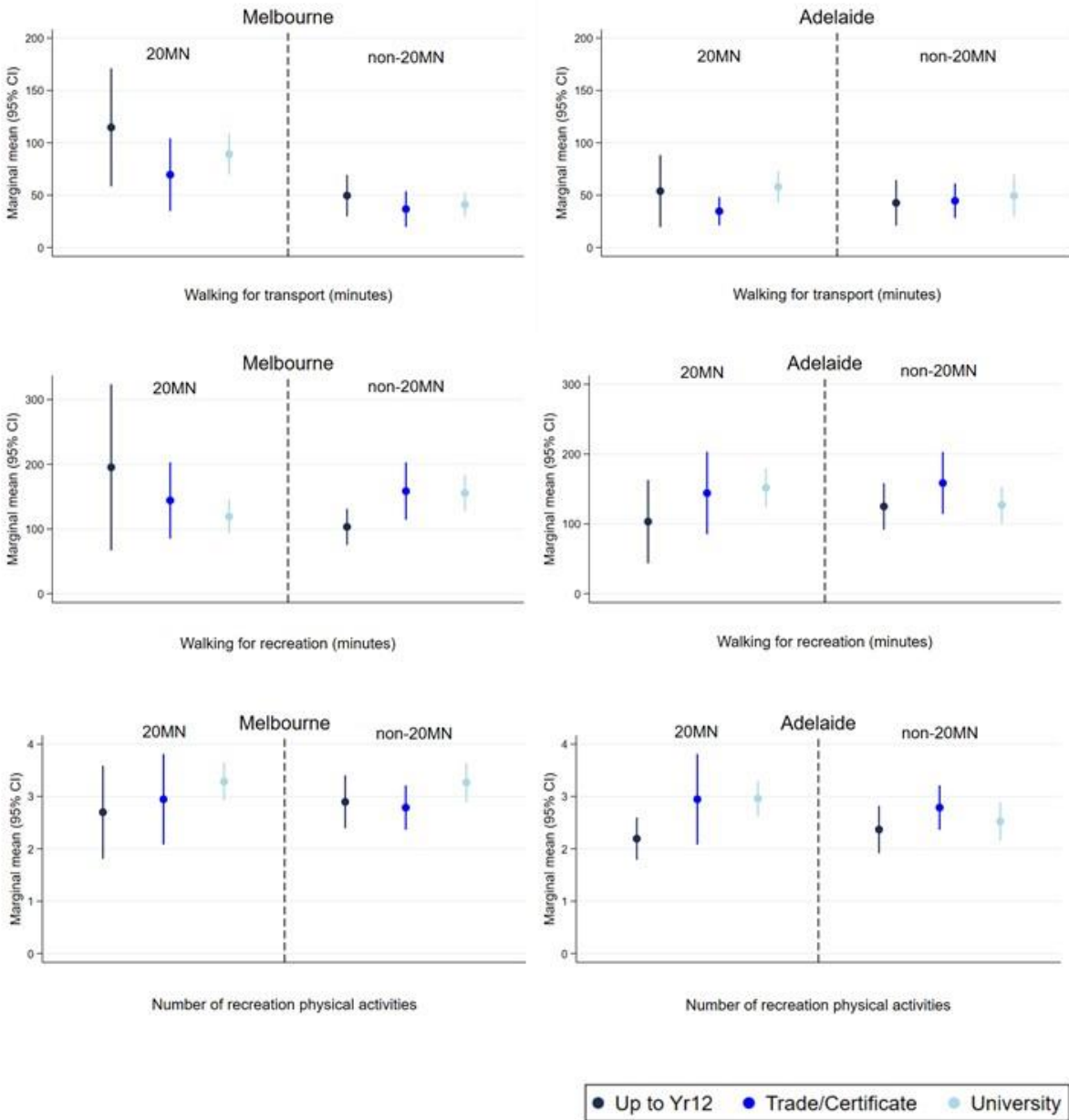


Figure 5. Predicted probability with 95% confidence intervals of self-rated health by neighbourhood type and area-SES for each city and sample from adjusted ordinal regression models.

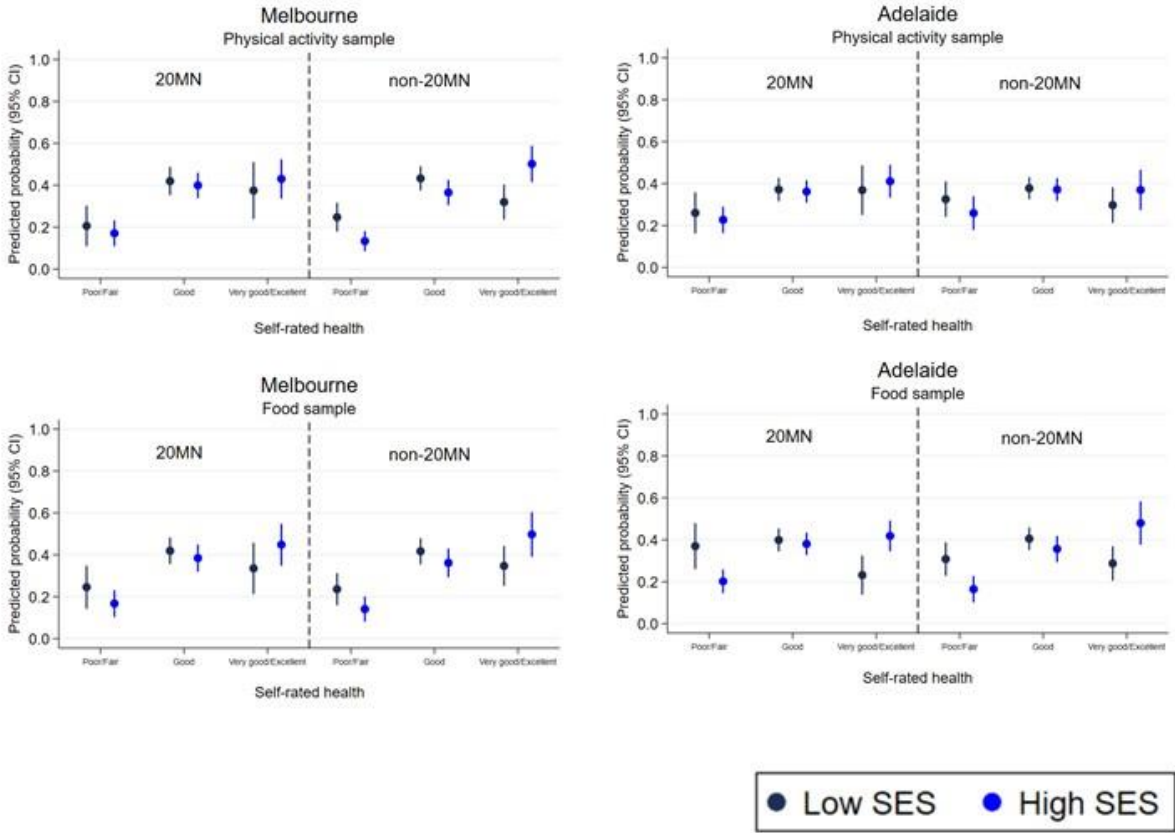
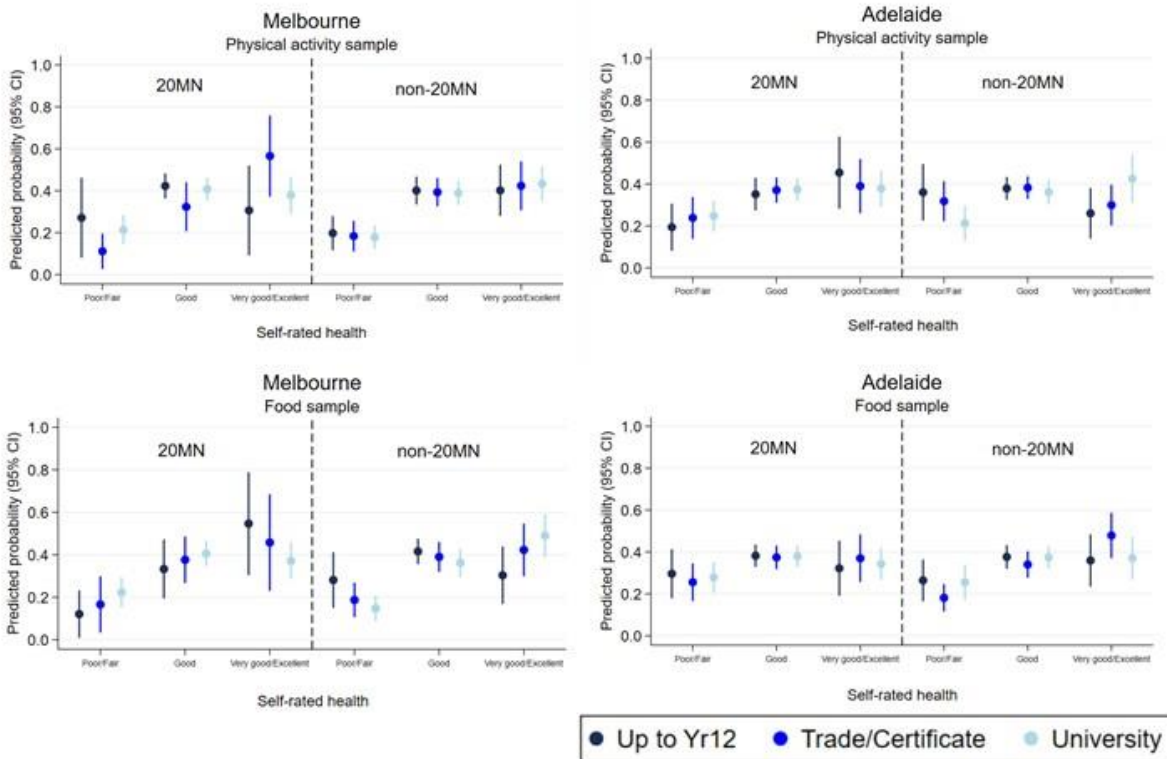
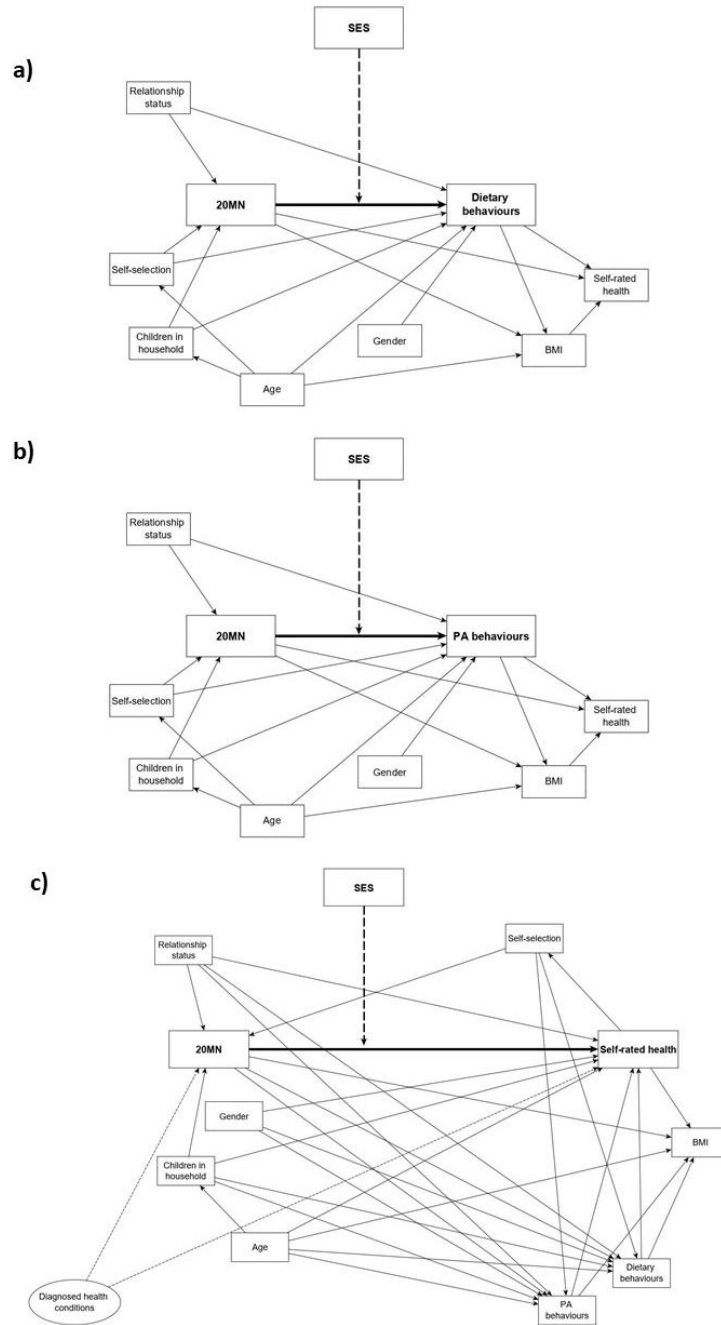


Figure 6. Predicted probability with 95% confidence intervals of self-rated health by neighbourhood type and highest qualification for each city and sample from adjusted ordinal regression models.



APPENDIX

Appendix Figure 1. Directed acyclic graph of the moderating effect of SES (individual- or area-level) on the relationship between living in a 20MN and a) dietary behaviours, b) physical activity behaviours, c) self-rated health.



*Diagnosed health conditions were not measured in ProjectPLAN.

Appendix Table 1. Comparison of descriptive characteristics for the complete case and omitted ProjectPLAN participant samples.

| Variables | Melbourne Food | | Adelaide Food | | Melbourne Physical Activity | | Adelaide Physical Activity | |
|---|-------------------|---------------|-------------------|---------------|-----------------------------|-----------------|----------------------------|------------------|
| | Omitted N = 69 | CC N = 289 | Omitted N = 58 | CC N = 353 | Omitted N = 66 | CC N = 337 | Omitted N = 68 | CC N = 335 |
| Fruit/day, % | | | | | | | | |
| <1 serve | 13.0% | 20.8% | 20.7% | 22.4% | n.c. | n.c. | n.c. | n.c. |
| 1 serve | 34.8% | 27.7% | 29.3% | 29.7% | n.c. | n.c. | n.c. | n.c. |
| ≥2 serves | 52.2% | 51.6% | 50.0% | 47.9% | n.c. | n.c. | n.c. | n.c. |
| Vegetables/day, % | | | | | | | | |
| <2 serves | 39.1% | 23.5% | 25.9% | 31.7% | n.c. | n.c. | n.c. | n.c. |
| 2 serves | 24.6% | 30.1% | 32.8% | 26.6% | n.c. | n.c. | n.c. | n.c. |
| ≥3 serves | 36.2% | 46.4% | 41.4% | 41.6% | n.c. | n.c. | n.c. | n.c. |
| Hot takeaway consumption, % | | | | | | | | |
| Never/less than once per month | 31.9% | 32.6% | 36.2% | 40.2% | n.c. | n.c. | n.c. | n.c. |
| Once every two weeks | 40.6% | 31.3% | 43.1% | 28.9% | n.c. | n.c. | n.c. | n.c. |
| At least once per week | 27.5% | 36.1% | 20.7% | 30.9% | n.c. | n.c. | n.c. | n.c. |
| Transport walking (mins/week), median (Q1, Q3) | n.c. | n.c. | n.c. | n.c. | 60 (0, 75) | 60 (0, 85) | 0 (0, 62.5) | 0 (0, 80) |
| Recreation walking (mins/week), median (Q1, Q3) | n.c. | n.c. | n.c. | n.c. | 90 (45, 180) | 90 (60, 180) | 120 (60, 180) | 120 (60, 200) |
| Number of exercise activities in past week, median (Q1, Q3) | n.c. | n.c. | n.c. | n.c. | 3 (2, 4) | 3 (2, 4) | 2 (1, 3) | 2 (1, 3) |
| Self-rated health, % | | | | | | | | |
| Poor/Fair | 29.8% | 19.4% | 38.1% | 24.9% | 18.8% | 19.3% | 22.5% | 26.6% |

| | | | | | | | | |
|---|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| <i>Good</i> | 31.9% | 38.8% | 40.5% | 37.7% | 46.9% | 39.5% | 45.0% | 36.7% |
| <i>Very Good/Excellent</i> | 38.3% | 41.9% | 21.4% | 37.4% | 34.4% | 41.2% | 32.5% | 36.7% |
| 20MN, % | | | | | | | | |
| <i>Yes</i> | 44.9% | 43.9% | 50.0% | 54.1% | 39.4% | 36.5% | 55.9% | 50.7% |
| Area-SES, % | | | | | | | | |
| <i>High SES</i> | 49.3% | 56.1% | 48.3% | 58.9% | 43.9% | 57.9% | 41.2% | 58.5% |
| Highest qualification, % | | | | | | | | |
| <i>Up to Year 12</i> | 19.7% | 15.6% | 35.3% | 22.1% | 24.0% | 19.0% | 33.3% | 20.3% |
| <i>Trade/Certificate</i> | 24.6% | 22.5% | 37.3% | 32.0% | 30.0% | 20.8% | 35.1% | 31.6% |
| <i>University</i> | 55.7% | 61.9% | 27.5% | 45.9% | 46.0% | 60.2% | 31.6% | 48.1% |
| Age (years), mean (SD) | 57.8 (15.5) | 51.7 (15.9) | 60.3 (17.2) | 56.4 (15.7) | 51.9 (16.2) | 48.8 (16.6) | 62.4 (15.7) | 57.4 (15.8) |
| Gender, % | | | | | | | | |
| <i>Female</i> | 65.1% | 59.9% | 61.5% | 60.9% | 57.1% | 56.7% | 61.7% | 56.4% |
| Children in household, % | | | | | | | | |
| <i>No children</i> | 71.9% | 67.1% | 72.7% | 78.5% | 68.0% | 67.1% | 79.7% | 76.7% |
| <i>Child(ren) up to 4 yrs</i> | 15.6% | 18.0% | 21.8% | 10.5% | 16.0% | 17.2% | 11.9% | 11.0% |
| <i>Only child(ren) > 4 yrs</i> | 12.5% | 14.9% | 5.5% | 11.0% | 16.0% | 15.7% | 8.5% | 12.2% |
| Relationship status, % | | | | | | | | |
| <i>Living with partner</i> | 50.8% | 65.7% | 67.3% | 63.2% | 63.8% | 62.6% | 58.2% | 63.0% |
| Supermarket important reason for moving/living here, % | 47.6% | 58.5% | 53.7% | 57.8% | n.c. | n.c. | n.c. | n.c. |
| Everyday needs within 20 minutes important reason for moving/living here, % | 50.0% | 55.0% | 54.1% | 53.3% | 35.7% | 46.0% | 52.8% | 50.1% |
| Park, open space or beach reason important for moving/living here, % | n.c. | n.c. | n.c. | n.c. | 58.1% | 61.1% | 61.5% | 63.0% |

| | | | | | | | | |
|---|---------------|---------------|------------|------------|------------|------------|------------|------------|
| Recreational facilities (e.g., gyms) important reason for moving/living here, % | n.c. | n.c. | n.c. | n.c. | 27.6% | 34.7% | 41.2% | 26.3% |
| BMI (kg/m ²), mean (SD) | 24.0 (4.5) | 25.3 (4.3) | 27.8 (4.9) | 26.8 (5.0) | 25.9 (4.2) | 25.7 (4.5) | 26.4 (4.8) | 26.8 (5.0) |

CC = complete case; n.c. = not collected; Q1 = quartile 1 (25th percentile); Q3 = quartile 3 (75th percentile); BMI = body mass index.

Findings in Table 2 show that consumption of vegetables was higher in the complete case food sample (3+ serves: 46%) compared to the omitted sample (36%) in Melbourne, the average age was younger (52 vs. 58 years), and a higher proportion lived with a partner (66% vs. 51%). In the Adelaide food sample, there was a higher consumption of hot takeaway food in the complete case (at least once per week: 31%) than the omitted sample (21%), a higher proportion with university education (46% vs. 28) and a lower proportion with poor/fair health (25% vs. 38%). In both the Melbourne and Adelaide physical activity samples, the proportion living in high SES areas was higher in the complete case samples (Melbourne: 58% vs. 44%; Adelaide: 59% vs. 41%), as was the proportion with university education (Melbourne: 60% vs. 46%; Adelaide: 48% vs. 32%).

Appendix Table 2. Ordinal regression models from complete case analysis assessing the moderating effect of area-SES and highest qualification on the relationship between neighbourhood type and each dietary behaviour outcome for each city.

| Melbourne (N=289) | | | | | | | | | | | | |
|--|-----------|------------------------------|----------|-----------|--------------------------------|----------|-----------|--------------------------------|----------|-----------|--------------------------------|----------|
| Interaction with area-SES | | | | | | | | | | | | |
| | OR | Unadjusted 95% CI | p | OR | Adjustment 1 95% CI | p | OR | Adjustment 2 95% CI | p | OR | Adjustment 3 95% CI | p |
| Fruit intake outcome | | | | | | | | | | | | |
| 20MN | 1.24 | (0.78, 1.97) | 0.355 | 1.70 | (0.83, 3.50) | 0.150 | 1.65 | (0.77, 3.56) | 0.198 | 1.71 | (0.79, 3.71) | 0.176 |
| High NH SES | 1.67 | (1.11, 2.52) | 0.013 | 1.25 | (0.68, 2.29) | 0.480 | 1.27 | (0.69, 2.33) | 0.449 | 1.15 | (0.62, 2.15) | 0.655 |
| 20MN:High NH SES | 0.72 | (0.39, 1.32) | 0.287 | 0.52 | (0.20, 1.33) | 0.169 | 0.52 | (0.20, 1.33) | 0.173 | 0.50 | (0.19, 1.30) | 0.153 |
| Vegetable intake | | | | | | | | | | | | |
| 20MN | 1.36 | (0.69, 2.66) | 0.373 | 1.41 | (0.70, 2.84) | 0.337 | 1.69 | (0.79, 3.62) | 0.175 | 1.82 | (0.84, 3.91) | 0.128 |
| High NH SES | 1.61 | (0.90, 2.88) | 0.107 | 1.15 | (0.61, 2.16) | 0.662 | 1.16 | (0.62, 2.17) | 0.650 | 1.10 | (0.58, 2.08) | 0.781 |
| 20MN:High NH SES | 0.67 | (0.28, 1.63) | 0.381 | 0.82 | (0.32, 2.11) | 0.684 | 0.80 | (0.31, 2.07) | 0.650 | 0.76 | (0.29, 1.97) | 0.567 |
| Hot take-away intake outcome | | | | | | | | | | | | |
| 20MN | 0.89 | (0.45, 1.73) | 0.721 | 0.78 | (0.38, 1.60) | 0.497 | 0.71 | (0.33, 1.54) | 0.386 | 0.66 | (0.30, 1.46) | 0.308 |
| High NH SES | 0.81 | (0.46, 1.41) | 0.451 | 0.98 | (0.53, 1.83) | 0.955 | 0.99 | (0.53, 1.84) | 0.964 | 1.12 | (0.59, 2.12) | 0.737 |
| 20MN:High NH SES | 0.93 | (0.39, 2.24) | 0.869 | 0.93 | (0.36, 2.42) | 0.888 | 0.94 | (0.36, 2.43) | 0.896 | 0.95 | (0.36, 2.51) | 0.922 |
| Interaction with individual-SES | | | | | | | | | | | | |
| Fruit intake outcome | | | | | | | | | | | | |
| 20MN | 0.43 | (0.14, 1.32) | 0.141 | 0.45 | (0.15, 1.39) | 0.167 | 0.39 | (0.12, 1.28) | 0.121 | 0.34 | (0.10, 1.12) | 0.077 |
| Trade/ Certificate | 0.89 | (0.39, 2.05) | 0.791 | 1.09 | (0.46, 2.58) | 0.841 | 1.08 | (0.46, 2.56) | 0.860 | 1.06 | (0.44, 2.57) | 0.893 |
| University | 1.00 | (0.46, 2.16) | 1.000 | 1.30 | (0.56, 3.00) | 0.536 | 1.27 | (0.55, 2.95) | 0.574 | 1.12 | (0.48, 2.65) | 0.794 |
| 20MN:Trade/ Certificate | 6.38 | (1.19, 34.18) | 0.030 | 8.00 | (1.44, 44.46) | 0.018 | 8.66 | (1.54, 48.85) | 0.014 | 9.94 | (1.72, 57.26) | 0.010 |

| | | | | | | | | | | | | |
|------------------------------------|-----------|------------------------------|----------|-----------|--------------------------------|----------|-----------|--------------------------------|----------|-----------|--------------------------------|----------|
| 20MN: University | 2.59 | (0.74, 9.03) | 0.135 | 2.49 | (0.70, 8.86) | 0.159 | 2.69 | (0.75, 9.69) | 0.130 | 3.41 | (0.91, 12.71) | 0.068 |
| Vegetable intake outcome | | | | | | | | | | | | |
| 20MN | 0.84 | (0.27, 2.61) | 0.766 | 0.90 | (0.28, 2.96) | 0.866 | 1.13 | (0.32, 3.93) | 0.849 | 1.07 | (0.30, 3.79) | 0.918 |
| Trade/ Certificate | 0.84 | (0.36, 1.96) | 0.685 | 1.01 | (0.41, 2.50) | 0.974 | 1.03 | (0.42, 2.53) | 0.955 | 1.01 | (0.41, 2.52) | 0.979 |
| University | 1.52 | (0.69, 3.35) | 0.301 | 1.71 | (0.70, 4.14) | 0.238 | 1.72 | (0.71, 4.19) | 0.233 | 1.66 | (0.67, 4.10) | 0.274 |
| 20MN:Trade /Certificate | 0.91 | (0.20, 4.13) | 0.902 | 1.08 | (0.22, 5.33) | 0.926 | 0.98 | (0.20, 4.86) | 0.979 | 1.05 | (0.21, 5.27) | 0.953 |
| 20MN: University | 1.27 | (0.36, 4.49) | 0.709 | 1.38 | (0.37, 5.18) | 0.636 | 1.29 | (0.34, 4.92) | 0.707 | 1.46 | (0.37, 5.76) | 0.587 |
| Hot takeaway intake outcome | | | | | | | | | | | | |
| 20MN | 0.94 | (0.30, 2.98) | 0.918 | 0.70 | (0.20, 2.44) | 0.576 | 0.63 | (0.18, 2.29) | 0.486 | 0.58 | (0.16, 2.12) | 0.412 |
| Trade/ Certificate | 2.03 | (0.87, 4.71) | 0.100 | 1.11 | (0.45, 2.73) | 0.817 | 1.13 | (0.46, 2.76) | 0.796 | 1.06 | (0.43, 2.65) | 0.894 |
| University | 2.52 | (1.16, 5.51) | 0.020 | 0.83 | (0.35, 1.96) | 0.668 | 0.84 | (0.35, 2.01) | 0.700 | 0.87 | (0.36, 2.09) | 0.752 |
| 20MN:Trade/ Certificate | 1.23 | (0.25, 6.07) | 0.797 | 1.09 | (0.20, 6.06) | 0.920 | 1.12 | (0.20, 6.24) | 0.894 | 1.03 | (0.19, 5.68) | 0.972 |
| 20MN: University | 0.71 | (0.20, 2.55) | 0.604 | 1.17 | (0.30, 4.60) | 0.824 | 1.18 | (0.30, 4.64) | 0.816 | 1.21 | (0.30, 4.83) | 0.787 |
| Adelaide (N=353) | | | | | | | | | | | | |
| Interaction with area-SES | | | | | | | | | | | | |
| | OR | Unadjusted 95% CI | p | OR | Adjustment 1 95% CI | p | OR | Adjustment 2 95% CI | p | OR | Adjustment 3 95% CI | p |
| Fruit intake outcome | | | | | | | | | | | | |
| 20MN | 1.01 | (0.55, 1.86) | 0.985 | 0.94 | (0.50, 1.77) | 0.845 | 0.94 | (0.49, 1.79) | 0.851 | 1.05 | (0.54, 2.01) | 0.893 |
| High NH SES | 1.91 | (1.07, 3.40) | 0.028 | 1.70 | (0.94, 3.07) | 0.077 | 1.70 | (0.94, 3.07) | 0.078 | 1.40 | (0.76, 2.57) | 0.275 |
| 20MN:High NH SES | 0.95 | (0.42, 2.14) | 0.897 | 1.10 | (0.48, 2.53) | 0.814 | 1.13 | (0.48, 2.63) | 0.780 | 1.07 | (0.46, 2.52) | 0.874 |
| Vegetable intake outcome | | | | | | | | | | | | |
| 20MN | 0.79 | (0.43, 1.45) | 0.448 | 0.75 | (0.40, 1.42) | 0.377 | 0.78 | (0.40, 1.50) | 0.455 | 0.83 | (0.43, 1.61) | 0.579 |

| | | | | | | | | | | | | |
|--|------|--------------|--------|------|--------------|--------|------|--------------|--------|------|--------------|-------|
| High NH SES | 2.15 | (1.20, 3.84) | 0.010 | 2.02 | (1.10, 3.68) | 0.022 | 2.00 | (1.10, 3.66) | 0.023 | 1.70 | (0.92, 3.15) | 0.090 |
| 20MN:High NH SES | 1.00 | (0.45, 2.26) | 0.993 | 1.19 | (0.52, 2.76) | 0.680 | 1.21 | (0.52, 2.83) | 0.653 | 1.18 | (0.50, 2.77) | 0.708 |
| Hot takeaway intake outcome | | | | | | | | | | | | |
| 20MN | 0.62 | (0.33, 1.16) | 0.133 | 0.67 | (0.35, 1.30) | 0.237 | 0.68 | (0.35, 1.34) | 0.269 | 0.56 | (0.28, 1.14) | 0.108 |
| High NH SES | 0.25 | (0.14, 0.45) | <0.001 | 0.29 | (0.16, 0.54) | <0.001 | 0.29 | (0.16, 0.54) | <0.001 | 0.35 | (0.18, 0.66) | 0.001 |
| 20MN:High NH SES | 2.50 | (1.10, 5.71) | 0.029 | 2.06 | (0.87, 4.86) | 0.098 | 2.09 | (0.88, 4.98) | 0.095 | 2.69 | (1.09, 6.62) | 0.031 |
| Interaction with individual-SES | | | | | | | | | | | | |
| Fruit intake outcome | | | | | | | | | | | | |
| 20MN | 0.89 | (0.40, 2.00) | 0.785 | 0.81 | (0.35, 1.86) | 0.618 | 0.82 | (0.35, 1.96) | 0.658 | 0.92 | (0.38, 2.20) | 0.845 |
| Trade/Certificate | 1.04 | (0.50, 2.17) | 0.911 | 1.01 | (0.48, 2.12) | 0.983 | 1.00 | (0.47, 2.10) | 0.995 | 0.95 | (0.45, 2.02) | 0.903 |
| University | 1.85 | (0.88, 3.90) | 0.106 | 1.56 | (0.72, 3.39) | 0.262 | 1.56 | (0.71, 3.40) | 0.268 | 1.61 | (0.73, 3.56) | 0.238 |
| 20MN:Trade/Certificate | 1.22 | (0.42, 3.54) | 0.710 | 1.20 | (0.41, 3.52) | 0.744 | 1.23 | (0.42, 3.64) | 0.708 | 1.25 | (0.42, 3.75) | 0.690 |
| 20MN:University | 1.20 | (0.43, 3.30) | 0.727 | 1.30 | (0.46, 3.67) | 0.615 | 1.32 | (0.47, 3.73) | 0.599 | 1.21 | (0.42, 3.47) | 0.721 |
| Vegetable intake outcome | | | | | | | | | | | | |
| 20MN | 0.64 | (0.28, 1.49) | 0.303 | 0.58 | (0.24, 1.40) | 0.222 | 0.64 | (0.26, 1.62) | 0.349 | 0.68 | (0.27, 1.73) | 0.421 |
| Trade/Certificate | 1.66 | (0.79, 3.48) | 0.177 | 1.68 | (0.79, 3.58) | 0.177 | 1.72 | (0.81, 3.67) | 0.159 | 1.62 | (0.75, 3.48) | 0.216 |
| University | 2.86 | (1.34, 6.11) | 0.007 | 2.31 | (1.05, 5.09) | 0.037 | 2.42 | (1.10, 5.37) | 0.029 | 2.33 | (1.04, 5.21) | 0.039 |
| 20MN:Trade/Certificate | 1.20 | (0.41, 3.57) | 0.740 | 1.18 | (0.39, 3.61) | 0.770 | 1.13 | (0.37, 3.49) | 0.826 | 1.13 | (0.36, 3.52) | 0.832 |
| 20MN:University | 1.53 | (0.54, 4.33) | 0.425 | 1.67 | (0.57, 4.93) | 0.351 | 1.63 | (0.55, 4.80) | 0.379 | 1.61 | (0.54, 4.83) | 0.391 |
| Hot takeaway intake outcome | | | | | | | | | | | | |
| 20MN | 1.06 | (0.46, 2.42) | 0.891 | 1.43 | (0.58, 3.48) | 0.436 | 1.41 | (0.56, 3.57) | 0.465 | 1.48 | (0.56, 3.87) | 0.426 |
| Trade/Certificate | 1.11 | (0.53, 2.31) | 0.784 | 1.20 | (0.55, 2.59) | 0.648 | 1.20 | (0.55, 2.59) | 0.650 | 1.38 | (0.62, 3.05) | 0.426 |
| University | 0.65 | (0.31, 1.39) | 0.267 | 0.80 | (0.36, 1.80) | 0.592 | 0.80 | (0.36, 1.80) | 0.590 | 0.98 | (0.43, 2.25) | 0.958 |

| | | | | | | | | | | | | |
|----------------------------|------|--------------|-------|------|--------------|-------|------|--------------|-------|------|--------------|-------|
| 20MN:Trade/ Certificate | 0.65 | (0.22, 1.91) | 0.435 | 0.59 | (0.19, 1.85) | 0.368 | 0.59 | (0.19, 1.85) | 0.369 | 0.52 | (0.16, 1.71) | 0.284 |
| 20MN: University | 0.95 | (0.34, 2.64) | 0.927 | 0.75 | (0.26, 2.22) | 0.607 | 0.75 | (0.26, 2.23) | 0.610 | 0.66 | (0.22, 2.03) | 0.472 |

20MN: 20-minute neighbourhood; NH: neighbourhood; SES: socioeconomic status; MI: multiple imputation; CC: complete case; Coef: coefficient; OR: odds ratio; CI: confidence interval. Adjustment 1 (sensitivity analysis without neighbourhood self-selection): age, gender, children in the household, relationship status [and area-SES in highest qualification models only]; Adjustment 2 (primary analysis): age, gender, children in the household, relationship status, self-selection [and area-SES in highest qualification models only]; Adjustment 3 (sensitivity analysis with BMI and self-rated health): age, gender, children in the household, relationship status, self-selection, BMI, self-rated health [and area-SES in highest qualification models only] .

Appendix Table 3. Two-part and Poisson regression models from complete case analysis assessing the moderating effect of area-SES and highest qualification on the relationship between neighbourhood type and each physical activity outcome for each city.

| Melbourne (N=337) | | | | | | | | |
|---|-------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| Interaction with area-SES | | | | | | | | |
| | Unadjusted | | Adjustment 1 | | Adjustment 2 | | Adjustment 3 | |
| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Transport walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| 20MN | 3.74 | (1.64, 8.52) | 3.69 | (1.57, 8.65) | 2.97 | (1.22, 7.23) | 0.72 | (0.34, 1.56) |
| High NH SES | 1.13 | (0.66, 1.94) | 1.31 | (0.72, 2.39) | 1.30 | (0.71, 2.37) | 1.17 | (0.57, 2.39) |
| 20MN:High NH SES | 1.84 | (0.62, 5.41) | 1.71 | (0.56, 5.20) | 1.67 | (0.55, 5.11) | 3.19 | (1.16, 8.77) |
| Two-part model: minutes of transport walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 1.11 | (0.81, 1.51) | 1.17 | (0.85, 1.62) | 1.27 | (0.91, 1.78) | 1.01 | (0.70, 1.47) |
| High NH SES | 0.98 | (0.75, 1.28) | 1.07 | (0.81, 1.42) | 1.07 | (0.80, 1.42) | 1.13 | (0.81, 1.58) |
| 20MN:High NH SES | 1.04 | (0.70, 1.54) | 1.02 | (0.68, 1.53) | 1.06 | (0.70, 1.58) | 0.91 | (0.57, 1.44) |
| Recreational walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| 20MN | 1.96 | (0.78, 4.93) | 2.17 | (0.83, 5.67) | 1.60 | (0.59, 4.32) | 1.53 | (0.56, 4.19) |
| High NH SES | 3.11 | (1.55, 6.24) | 2.43 | (1.15, 5.11) | 2.32 | (1.08, 4.98) | 2.06 | (0.92, 4.60) |
| 20MN:High NH SES | 0.42 | (0.12, 1.44) | 0.36 | (0.10, 1.29) | 0.36 | (0.10, 1.31) | 0.38 | (0.10, 1.42) |
| Two-part model: minutes of recreational walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 0.84 | (0.61, 1.16) | 0.81 | (0.59, 1.13) | 0.78 | (0.56, 1.09) | 0.75 | (0.54, 1.04) |
| High NH SES | 1.07 | (0.85, 1.35) | 1.04 | (0.81, 1.34) | 1.03 | (0.81, 1.32) | 0.98 | (0.76, 1.26) |

| | | | | | | | | |
|---|-------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| 20MN:High NH SES | 1.19 | (0.80, 1.77) | 1.24 | (0.83, 1.86) | 1.25 | (0.84, 1.86) | 1.28 | (0.86, 1.90) |
| Number of activities for exercise/recreational physical activity | | | | | | | | |
| | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI |
| 20MN | 1.19 | (0.92, 1.54) | 1.15 | (0.90, 1.48) | 0.99 | (0.78, 1.26) | 0.97 | (0.77, 1.23) |
| High NH SES | 1.20 | (1.01, 1.43) | 1.23 | (1.04, 1.46) | 1.20 | (1.02, 1.42) | 1.11 | (0.94, 1.30) |
| 20MN:High NH SES | 1.01 | (0.75, 1.37) | 1.00 | (0.75, 1.33) | 1.03 | (0.77, 1.36) | 1.06 | (0.81, 1.40) |
| Interaction with individual-SES | | | | | | | | |
| | Unadjusted | | Adjustment 1 | | Adjustment 2 | | Adjustment 3 | |
| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Transport walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| 20MN | 3.97 | (0.99, 15.98) | 4.66 | (1.10, 19.68) | 3.33 | (0.75, 14.85) | 3.11 | (0.68, 14.13) |
| Trade/ Certificate | 0.53 | (0.24, 1.17) | 0.68 | (0.29, 1.57) | 0.65 | (0.28, 1.53) | 0.67 | (0.28, 1.58) |
| University | 0.94 | (0.48, 1.83) | 1.04 | (0.51, 2.15) | 1.10 | (0.53, 2.27) | 1.12 | (0.53, 2.33) |
| 20MN:Trade/ Certificate | 1.35 | (0.22, 8.37) | 0.92 | (0.14, 6.07) | 1.15 | (0.17, 7.74) | 1.36 | (0.20, 9.40) |
| 20MN: University | 1.47 | (0.31, 6.89) | 1.17 | (0.24, 5.74) | 1.28 | (0.26, 6.31) | 1.39 | (0.28, 7.07) |
| Two-part model: minutes of transport walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 1.25 | (0.79, 1.98) | 1.29 | (0.80, 2.07) | 1.49 | (0.91, 2.44) | 1.48 | (0.89, 2.45) |
| Trade/ Certificate | 0.90 | (0.61, 1.35) | 0.91 | (0.59, 1.40) | 0.93 | (0.61, 1.43) | 0.93 | (0.61, 1.43) |
| University | 0.80 | (0.59, 1.09) | 0.81 | (0.57, 1.13) | 0.79 | (0.56, 1.10) | 0.78 | (0.55, 1.10) |
| 20MN:Trade/ Certificate | 0.76 | (0.39, 1.46) | 0.75 | (0.38, 1.50) | 0.70 | (0.35, 1.40) | 0.71 | (0.35, 1.43) |
| 20MN: University | 0.97 | (0.58, 1.63) | 0.95 | (0.56, 1.61) | 0.92 | (0.54, 1.55) | 0.93 | (0.54, 1.60) |
| Recreational walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |

| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
|---|------------|---------------|------------|---------------|------------|---------------|------------|---------------|
| 20MN | 2.82 | (0.56, 14.13) | 2.75 | (0.52, 14.46) | 1.48 | (0.26, 8.45) | 1.69 | (0.30, 9.63) |
| Trade/ Certificate | 1.57 | (0.65, 3.77) | 1.22 | (0.48, 3.13) | 1.07 | (0.41, 2.80) | 1.02 | (0.38, 2.73) |
| University | 2.30 | (1.06, 4.99) | 1.62 | (0.70, 3.76) | 1.74 | (0.74, 4.10) | 1.69 | (0.70, 4.07) |
| 20MN:Trade/ Certificate | 0.37 | (0.05, 2.92) | 0.60 | (0.07, 5.15) | 0.87 | (0.10, 7.81) | 0.65 | (0.07, 5.95) |
| 20MN: University | 0.40 | (0.07, 2.36) | 0.33 | (0.05, 2.10) | 0.49 | (0.07, 3.26) | 0.43 | (0.07, 2.89) |
| Two-part model: minutes of recreational walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 2.03 | (1.24, 3.33) | 1.88 | (1.14, 3.10) | 1.76 | (1.06, 2.94) | 1.72 | (1.03, 2.86) |
| Trade/ Certificate | 1.58 | (1.12, 2.23) | 1.54 | (1.09, 2.19) | 1.52 | (1.07, 2.15) | 1.50 | (1.06, 2.13) |
| University | 1.40 | (1.04, 1.88) | 1.37 | (1.01, 1.86) | 1.37 | (1.01, 1.86) | 1.37 | (1.01, 1.86) |
| 20MN:Trade/ Certificate | 0.43 | (0.22, 0.84) | 0.47 | (0.24, 0.92) | 0.49 | (0.25, 0.97) | 0.48 | (0.24, 0.95) |
| 20MN: University | 0.42 | (0.24, 0.72) | 0.44 | (0.25, 0.76) | 0.46 | (0.26, 0.80) | 0.46 | (0.27, 0.80) |
| Number of activities for exercise/recreational physical activity | | | | | | | | |
| | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI |
| 20MN | 1.14 | (0.78, 1.66) | 1.19 | (0.84, 1.68) | 0.93 | (0.64, 1.36) | 0.95 | (0.68, 1.33) |
| Trade/ Certificate | 0.93 | (0.72, 1.20) | 1.00 | (0.79, 1.27) | 0.96 | (0.76, 1.22) | 0.96 | (0.78, 1.20) |
| University | 1.10 | (0.88, 1.37) | 1.10 | (0.89, 1.36) | 1.13 | (0.91, 1.39) | 1.11 | (0.91, 1.36) |
| 20MN:Trade/ Certificate | 1.09 | (0.65, 1.83) | 0.98 | (0.59, 1.61) | 1.13 | (0.68, 1.88) | 1.05 | (0.66, 1.66) |
| 20MN: University | 1.06 | (0.71, 1.60) | 0.97 | (0.66, 1.42) | 1.08 | (0.72, 1.61) | 1.08 | (0.75, 1.56) |
| Adelaide (N=335) | | | | | | | | |
| Interaction with area-SES | | | | | | | | |

| | Unadjusted | | Adjustment 1 | | Adjustment 2 | | Adjustment 3 | |
|---|-------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Transport walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| 20MN | 0.83 | (0.40, 1.72) | 0.80 | (0.38, 1.68) | 0.73 | (0.34, 1.55) | 0.72 | (0.34, 1.56) |
| High NH SES | 0.90 | (0.48, 1.70) | 1.02 | (0.51, 2.06) | 1.17 | (0.57, 2.40) | 1.17 | (0.57, 2.39) |
| 20MN:High NH SES | 4.39 | (1.71, 11.27) | 4.27 | (1.62, 11.23) | 3.18 | (1.17, 8.68) | 3.19 | (1.16, 8.77) |
| Two-part model: minutes of transport walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 0.95 | (0.67, 1.36) | 0.97 | (0.67, 1.40) | 0.98 | (0.68, 1.42) | 1.01 | (0.70, 1.47) |
| High NH SES | 1.16 | (0.85, 1.57) | 1.13 | (0.82, 1.56) | 1.12 | (0.81, 1.56) | 1.13 | (0.81, 1.58) |
| 20MN:High NH SES | 0.90 | (0.58, 1.39) | 0.89 | (0.57, 1.40) | 0.90 | (0.57, 1.43) | 0.91 | (0.57, 1.44) |
| Recreational walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| 20MN | 0.56 | (0.26, 1.23) | 0.57 | (0.25, 1.28) | 0.58 | (0.26, 1.31) | 0.51 | (0.22, 1.19) |
| High NH SES | 1.16 | (0.53, 2.52) | 0.83 | (0.35, 1.94) | 0.80 | (0.34, 1.90) | 0.75 | (0.31, 1.80) |
| 20MN:High NH SES | 2.96 | (0.96, 9.12) | 3.28 | (1.03, 10.41) | 3.07 | (0.96, 9.83) | 3.21 | (0.99, 10.40) |
| Two-part model: minutes of recreational walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 0.95 | (0.73, 1.24) | 0.93 | (0.71, 1.22) | 0.96 | (0.73, 1.25) | 0.92 | (0.70, 1.20) |
| High NH SES | 1.10 | (0.88, 1.38) | 1.04 | (0.82, 1.32) | 1.03 | (0.81, 1.31) | 1.03 | (0.81, 1.30) |
| 20MN:High NH SES | 1.19 | (0.85, 1.66) | 1.22 | (0.87, 1.71) | 1.17 | (0.83, 1.65) | 1.19 | (0.85, 1.67) |
| Number of activities for exercise/recreational physical activity | | | | | | | | |
| | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI |
| 20MN | 0.92 | (0.74, 1.13) | 0.88 | (0.72, 1.08) | 0.91 | (0.75, 1.11) | 0.86 | (0.71, 1.04) |
| High NH SES | 1.10 | (0.91, 1.32) | 1.05 | (0.88, 1.26) | 1.02 | (0.84, 1.23) | 0.97 | (0.81, 1.17) |
| 20MN:High NH SES | 1.39 | (1.06, 1.81) | 1.38 | (1.07, 1.79) | 1.41 | (1.07, 1.86) | 1.47 | (1.13, 1.92) |

| Interaction with individual-SES | | | | | | | | |
|--|-------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| | Unadjusted | | Adjustment 1 | | Adjustment 2 | | Adjustment 3 | |
| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Transport walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| 20MN | 3.13 | (1.14, 8.61) | 2.73 | (0.96, 7.79) | 2.12 | (0.72, 6.23) | 2.22 | (0.74, 6.67) |
| Trade/ Certificate | 1.18 | (0.51, 2.71) | 1.07 | (0.45, 2.56) | 1.00 | (0.42, 2.42) | 1.00 | (0.41, 2.42) |
| University | 1.48 | (0.64, 3.41) | 1.07 | (0.43, 2.64) | 1.12 | (0.45, 2.78) | 1.13 | (0.45, 2.86) |
| 20MN:Trade/ Certificate | 0.50 | (0.14, 1.82) | 0.50 | (0.13, 1.87) | 0.48 | (0.13, 1.87) | 0.45 | (0.12, 1.78) |
| 20MN: University | 0.69 | (0.21, 2.31) | 0.73 | (0.21, 2.54) | 0.63 | (0.18, 2.25) | 0.60 | (0.17, 2.21) |
| Two-part model: minutes of transport walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 0.87 | (0.56, 1.34) | 0.89 | (0.57, 1.39) | 0.90 | (0.58, 1.42) | 0.96 | (0.60, 1.54) |
| Trade/ Certificate | 1.04 | (0.69, 1.56) | 1.04 | (0.69, 1.57) | 1.05 | (0.69, 1.58) | 1.08 | (0.71, 1.64) |
| University | 1.10 | (0.73, 1.64) | 1.10 | (0.72, 1.67) | 1.10 | (0.72, 1.67) | 1.12 | (0.73, 1.72) |
| 20MN:Trade/ Certificate | 0.84 | (0.48, 1.49) | 0.84 | (0.47, 1.51) | 0.85 | (0.47, 1.52) | 0.82 | (0.45, 1.49) |
| 20MN: University | 1.14 | (0.68, 1.91) | 1.12 | (0.66, 1.89) | 1.13 | (0.67, 1.92) | 1.10 | (0.64, 1.89) |
| Recreational walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| | OR | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| 20MN | 0.48 | (0.16, 1.40) | 0.42 | (0.14, 1.30) | 0.41 | (0.13, 1.26) | 0.31 | (0.09, 1.01) |
| Trade/ Certificate | 1.24 | (0.47, 3.27) | 1.08 | (0.40, 2.95) | 1.01 | (0.37, 2.79) | 0.88 | (0.31, 2.49) |
| University | 1.23 | (0.46, 3.30) | 0.81 | (0.28, 2.36) | 0.80 | (0.27, 2.32) | 0.63 | (0.21, 1.92) |
| 20MN:Trade/ Certificate | 2.76 | (0.61, 12.59) | 3.00 | (0.63, 14.32) | 3.22 | (0.67, 15.46) | 3.77 | (0.75, 18.95) |

| | | | | | | | | |
|---|------------|---------------|------------|---------------|------------|---------------|------------|---------------|
| 20MN: University | 3.01 | (0.76, 11.97) | 3.60 | (0.86, 15.07) | 3.60 | (0.86, 15.10) | 4.77 | (1.07, 21.21) |
| Two-part model: minutes of recreational walking (if any) | | | | | | | | |
| | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI | GMR | 95% CI |
| 20MN | 1.08 | (0.74, 1.60) | 0.98 | (0.66, 1.46) | 1.01 | (0.68, 1.50) | 0.93 | (0.62, 1.38) |
| Trade/ Certificate | 1.26 | (0.95, 1.69) | 1.21 | (0.90, 1.63) | 1.19 | (0.89, 1.60) | 1.17 | (0.87, 1.57) |
| University | 1.16 | (0.86, 1.56) | 1.06 | (0.78, 1.44) | 1.06 | (0.78, 1.44) | 0.99 | (0.73, 1.36) |
| 20MN:Trade/ Certificate | 0.93 | (0.57, 1.50) | 0.99 | (0.61, 1.61) | 0.98 | (0.61, 1.59) | 1.03 | (0.63, 1.66) |
| 20MN: University | 1.06 | (0.67, 1.66) | 1.16 | (0.73, 1.83) | 1.11 | (0.70, 1.75) | 1.19 | (0.75, 1.89) |
| Number of activities for exercise/recreational physical activity | | | | | | | | |
| | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI | IRR | 95% CI |
| 20MN | 0.95 | (0.74, 1.22) | 0.91 | (0.71, 1.17) | 0.93 | (0.72, 1.20) | 0.81 | (0.63, 1.05) |
| Trade/ Certificate | 0.97 | (0.77, 1.23) | 0.96 | (0.76, 1.22) | 0.94 | (0.74, 1.19) | 0.90 | (0.71, 1.13) |
| University | 1.17 | (0.93, 1.47) | 1.08 | (0.85, 1.37) | 1.07 | (0.84, 1.35) | 0.95 | (0.75, 1.19) |
| 20MN:Trade/ Certificate | 1.15 | (0.82, 1.63) | 1.17 | (0.84, 1.65) | 1.20 | (0.85, 1.69) | 1.30 | (0.93, 1.81) |
| 20MN: University | 1.27 | (0.93, 1.72) | 1.28 | (0.94, 1.74) | 1.27 | (0.93, 1.72) | 1.47 | (1.09, 1.99) |

20MN: 20-minute neighbourhood; NH: neighbourhood; SES: socioeconomic status; Coef: coefficient; OR: odds ratio; GMR: geometric mean ratio; IRR: incidence rate ratio; CI: confidence interval. Adjustment 1 (sensitivity analysis without neighbourhood self-selection): age, gender, children in the household, relationship status [and area-SES in highest qualification models or highest qualification in area-SES models]; Adjustment 2 (primary analysis): age, gender, children in the household, relationship status, self-selection [and area-SES in highest qualification models or highest qualification in area-SES models]; Adjustment 3 (sensitivity analysis with BMI and self-rated health): age, gender, children in the household, relationship status, self-selection, BMI, self-rated health [and area-SES in highest qualification models or highest qualification in area-SES models].

Appendix Table 4. Ordinal regression models from complete case analysis assessing the moderating effect of area-SES and highest qualification on the relationship between neighbourhood type and self-rated health for each city.

| Melbourne (Food survey participants, N=289) | | | | | | | | | |
|---|-----------|------------------------------|----------|-----------|--------------------------------|----------|-----------|--------------------------------|----------|
| Interaction with area-SES | | | | | | | | | |
| | OR | Unadjusted 95% CI | p | OR | Adjustment 1 95% CI | p | OR | Adjustment 2 95% CI | p |
| 20MN High NH SES | 0.99 | (0.50, 1.96) | 0.977 | 0.98 | (0.49, 1.95) | 0.945 | 0.95 | (0.47, 1.90) | 0.875 |
| 20MN:High NH SES | 2.55 | (1.41, 4.59) | 0.002 | 2.20 | (1.18, 4.10) | 0.013 | 1.94 | (1.03, 3.65) | 0.039 |
| | 0.74 | (0.30, 1.82) | 0.514 | 0.80 | (0.31, 2.03) | 0.633 | 0.86 | (0.33, 2.20) | 0.746 |
| Interaction with individual-SES | | | | | | | | | |
| 20MN Trade/ Certificate University | 2.68 | (0.80, 8.99) | 0.111 | 2.75 | (0.79, 9.62) | 0.113 | 3.08 | (0.87, 10.93) | 0.082 |
| 20MN:Trade / Certificate 20MN: University | 1.23 | (0.55, 2.76) | 0.621 | 1.57 | (0.67, 3.64) | 0.296 | 1.77 | (0.75, 4.19) | 0.191 |
| | 2.17 | (1.02, 4.63) | 0.044 | 2.40 | (1.05, 5.50) | 0.038 | 2.40 | (1.03, 5.57) | 0.042 |
| | 0.37 | (0.07, 1.91) | 0.235 | 0.38 | (0.07, 2.07) | 0.262 | 0.38 | (0.07, 2.06) | 0.262 |
| | 0.24 | (0.06, 0.90) | 0.035 | 0.21 | (0.05, 0.84) | 0.027 | 0.19 | (0.05, 0.76) | 0.019 |
| Melbourne (Physical activity survey participants, N=337) | | | | | | | | | |
| Interaction with area-SES | | | | | | | | | |
| | OR | Unadjusted 95% CI | p | OR | Adjustment 1 95% CI | p | OR | Adjustment 2 95% CI | p |
| 20MN High NH SES | 1.57 | (0.78, 3.18) | 0.205 | 1.55 | (0.76, 3.15) | 0.231 | 1.30 | (0.63, 2.67) | 0.474 |
| | 2.86 | (1.71, 4.77) | <0.001 | 2.86 | (1.68, 4.88) | <0.001 | 2.29 | (1.32, 3.97) | 0.003 |

| | | | | | | | | | |
|--|-----------|--------------------------|----------|-----------|----------------------------|----------|-----------|----------------------------|----------|
| 20MN:High NH SES | 0.51 | (0.21, 1.25) | 0.141 | 0.53 | (0.22, 1.29) | 0.164 | 0.56 | (0.23, 1.38) | 0.209 |
| Interaction with individual-SES | | | | | | | | | |
| 20MN Trade/ Certificate University | 0.63 | (0.20, 2.05) | 0.446 | 0.69 | (0.20, 2.34) | 0.551 | 0.63 | (0.19, 2.10) | 0.448 |
| 20MN:Trade / Certificate | 1.07 | (0.52, 2.18) | 0.862 | 1.12 | (0.53, 2.35) | 0.768 | 1.11 | (0.52, 2.36) | 0.792 |
| 20MN: University | 1.49 | (0.80, 2.80) | 0.211 | 1.14 | (0.59, 2.21) | 0.696 | 1.16 | (0.59, 2.28) | 0.672 |
| 20MN:Trade / Certificate | 3.29 | (0.71, 15.32) | 0.129 | 3.23 | (0.66, 15.90) | 0.149 | 3.07 | (0.63, 15.01) | 0.165 |
| 20MN: University | 1.65 | (0.46, 5.96) | 0.443 | 1.30 | (0.34, 4.94) | 0.700 | 1.24 | (0.33, 4.67) | 0.751 |
| Adelaide (Food survey participants, N=353) | | | | | | | | | |
| Interaction with area-SES | | | | | | | | | |
| | OR | Unadjusted 95% CI | p | OR | Adjustment 1 95% CI | p | OR | Adjustment 2 95% CI | p |
| 20MN High NH SES | 0.65 | (0.35, 1.21) | 0.170 | 0.65 | (0.35, 1.23) | 0.186 | 0.73 | (0.38, 1.42) | 0.355 |
| 20MN:High NH SES | 2.75 | (1.53, 4.96) | 0.001 | 2.73 | (1.50, 4.96) | 0.001 | 2.49 | (1.35, 4.59) | 0.004 |
| 20MN:High NH SES | 1.34 | (0.59, 3.05) | 0.487 | 1.35 | (0.59, 3.08) | 0.482 | 1.04 | (0.44, 2.45) | 0.935 |
| Interaction with individual-SES | | | | | | | | | |
| 20MN Trade/ Certificate University | 0.91 | (0.39, 2.12) | 0.830 | 0.76 | (0.32, 1.80) | 0.531 | 0.83 | (0.33, 2.04) | 0.678 |
| 20MN:Trade / Certificate | 1.68 | (0.80, 3.51) | 0.172 | 1.72 | (0.81, 3.64) | 0.155 | 1.79 | (0.83, 3.86) | 0.138 |
| 20MN: University | 1.73 | (0.83, 3.63) | 0.144 | 1.32 | (0.61, 2.83) | 0.483 | 1.06 | (0.48, 2.35) | 0.887 |
| 20MN:Trade / Certificate | 0.81 | (0.27, 2.42) | 0.706 | 0.85 | (0.28, 2.57) | 0.770 | 0.71 | (0.23, 2.26) | 0.567 |
| 20MN: University | 1.25 | (0.45, 3.49) | 0.667 | 1.13 | (0.40, 3.19) | 0.818 | 1.05 | (0.36, 3.09) | 0.932 |
| Adelaide (Physical activity survey participants, N=335) | | | | | | | | | |

| Interaction with area-SES | | | | | | | | | |
|--|-------------------|---------------|----------|---------------------|---------------|----------|---------------------|---------------|----------|
| | Unadjusted | | | Adjustment 1 | | | Adjustment 2 | | |
| | OR | 95% CI | p | OR | 95% CI | p | OR | 95% CI | p |
| 20MN | 1.61 | (0.85, 3.06) | 0.146 | 1.63 | (0.85, 3.11) | 0.139 | 1.41 | (0.73, 2.75) | 0.307 |
| High NH | | | | | | | | | |
| SES | 1.69 | (0.95, 3.00) | 0.072 | 1.53 | (0.85, 2.75) | 0.155 | 1.42 | (0.78, 2.57) | 0.246 |
| 20MN:High | | | | | | | | | |
| NH SES | 0.82 | (0.36, 1.88) | 0.638 | 0.87 | (0.37, 2.01) | 0.738 | 0.85 | (0.36, 2.01) | 0.716 |
| Interaction with individual-SES | | | | | | | | | |
| 20MN | 3.91 | (1.52, 10.05) | 0.005 | 3.74 | (1.44, 9.70) | 0.007 | 2.51 | (0.95, 6.66) | 0.064 |
| Trade/ | | | | | | | | | |
| Certificate | 1.53 | (0.73, 3.18) | 0.259 | 1.49 | (0.71, 3.13) | 0.296 | 1.23 | (0.57, 2.64) | 0.597 |
| University | 3.43 | (1.60, 7.38) | 0.002 | 2.92 | (1.31, 6.51) | 0.009 | 2.22 | (0.98, 5.02) | 0.057 |
| 20MN:Trade | | | | | | | | | |
| / Certificate | 0.40 | (0.12, 1.29) | 0.126 | 0.43 | (0.13, 1.41) | 0.164 | 0.61 | (0.18, 2.06) | 0.428 |
| 20MN: | | | | | | | | | |
| University | 0.22 | (0.07, 0.68) | 0.008 | 0.23 | (0.08, 0.72) | 0.012 | 0.32 | (0.10, 1.01) | 0.053 |

20MN: 20-minute neighbourhood; NH: neighbourhood; SES: socioeconomic status; OR: odds ratio; CI: confidence interval. Adjustment 1 (primary analysis): age, gender, children in the household, relationship status [and area-SES in highest qualification models or highest qualification in area-SES models]; Adjustment 2 (sensitivity analysis adjusting for BMI): age, gender, children in the household, relationship status, BMI [and area-SES in highest qualification models or highest qualification in area-SES models].

Appendix Table 5. Comparison of covariate adjusted* models of dietary behaviours for multiple imputed (20 imputed datasets) and complete case data.

| Food survey participants | | | | | | | | | | | | |
|--|----------------------------|---------------|----------|----------------------|---------------|----------|----------------------------|----------------|----------|----------------------|----------------|----------|
| Interaction with area-SES | | | | | | | | | | | | |
| | Melbourne | | | | | | Adelaide | | | | | |
| | Multiple imputation | | | Complete case | | | Multiple imputation | | | Complete case | | |
| | Coef. | 95% CI | p | Coef. | 95% CI | p | Coef. | 95% CI | p | Coef. | 95% CI | p |
| Fruit intake outcome | | | | | | | | | | | | |
| 20MN | 0.31 | (-0.37, 0.98) | 0.372 | 0.54 | (-0.24, 1.33) | 0.176 | 0.23 | (-0.36, 0.82) | 0.442 | -0.02 | (-0.67, 0.63) | 0.944 |
| High NH SES | 0.38 | (-0.19, 0.94) | 0.192 | 0.15 | (-0.47, 0.76) | 0.638 | 0.59 | (0.02, 1.16) | 0.041 | 0.39 | (-0.21, 1.00) | 0.203 |
| 20MN:High NH SES | -0.72 | (-1.57, 0.12) | 0.094 | -0.68 | (-1.64, 0.28) | 0.165 | -0.24 | (-1.03, 0.55) | 0.558 | 0.03 | (-0.82, 0.88) | 0.948 |
| Vegetable intake outcome | | | | | | | | | | | | |
| 20MN | 0.38 | (-0.29, 1.06) | 0.265 | 0.44 | (-0.34, 1.22) | 0.271 | 0.11 | (-0.48, 0.71) | 0.706 | -0.20 | (-0.86, 0.47) | 0.563 |
| High NH SES | 0.21 | (-0.36, 0.78) | 0.474 | 0.11 | (-0.52, 0.73) | 0.740 | 0.69 | (0.13, 1.25) | 0.016 | 0.54 | (-0.08, 1.16) | 0.089 |
| 20MN:High NH SES | -0.17 | (-1.02, 0.67) | 0.692 | -0.31 | (-1.27, 0.65) | 0.530 | -0.36 | (-1.15, 0.43) | 0.369 | 0.01 | (-0.85, 0.88) | 0.973 |
| Hot take-away intake outcome | | | | | | | | | | | | |
| 20MN | -0.47 | (-1.16, 0.22) | 0.184 | -0.27 | (-1.06, 0.52) | 0.507 | -0.46 | (-1.07, 0.15) | 0.137 | -0.39 | (-1.06, 0.29) | 0.261 |
| High NH SES | -0.25 | (-0.82, 0.32) | 0.382 | -0.02 | (-0.64, 0.60) | 0.948 | -1.00 | (-1.58, -0.42) | 0.001 | -1.15 | (-1.78, -0.52) | <0.001 |
| 20MN:High NH SES | 0.34 | (-0.52, 1.19) | 0.437 | -0.05 | (-1.00, 0.90) | 0.919 | 0.88 | (0.08, 1.69) | 0.032 | 0.81 | (-0.07, 1.68) | 0.071 |
| Interaction with individual-SES | | | | | | | | | | | | |
| Fruit intake outcome | | | | | | | | | | | | |
| 20MN | -0.75 | (-1.82, 0.32) | 0.17 | -0.98 | (-2.18, 0.22) | 0.108 | 0.21 | (-0.58, 0.99) | 0.606 | -0.20 | (-1.06, 0.67) | 0.658 |
| Trade/Certificate | 0.05 | (-0.73, 0.83) | 0.902 | -0.06 | (-0.90, 0.78) | 0.885 | 0.00 | (-0.69, 0.68) | 0.990 | 0.00 | (-0.75, 0.74) | 0.995 |
| University | 0.25 | (-0.50, 1.01) | 0.508 | 0.22 | (-0.63, 1.07) | 0.609 | 0.66 | (-0.06, 1.39) | 0.074 | 0.44 | (-0.34, 1.22) | 0.268 |

| | | | | | | | | | | | | |
|---------------------------------|-------|---------------|-------|-------|---------------|-------|-------|---------------|-------|-------|---------------|-------|
| 20MN:Trade/ Certificate | 1.33 | (-0.13, 2.78) | 0.073 | 2.39 | (0.65, 4.13) | 0.007 | 0.00 | (-1.00, 1.01) | 0.994 | 0.21 | (-0.88, 1.29) | 0.708 |
| 20MN: University | 0.62 | (-0.54, 1.78) | 0.297 | 1.07 | (-0.23, 2.37) | 0.107 | -0.24 | (-1.22, 0.73) | 0.624 | 0.28 | (-0.76, 1.32) | 0.599 |
| Vegetable intake outcome | | | | | | | | | | | | |
| 20MN Trade/ Certificate | 0.16 | (-0.98, 1.30) | 0.781 | 0.11 | (-1.16, 1.38) | 0.864 | -0.04 | (-0.84, 0.77) | 0.928 | -0.44 | (-1.36, 0.48) | 0.349 |
| University | -0.12 | (-0.95, 0.71) | 0.779 | 0.10 | (-0.79, 0.99) | 0.824 | 0.43 | (-0.25, 1.12) | 0.213 | 0.54 | (-0.21, 1.30) | 0.159 |
| 20MN:Trade/ Certificate | 0.45 | (-0.34, 1.25) | 0.262 | 0.58 | (-0.32, 1.49) | 0.207 | 0.77 | (0.05, 1.49) | 0.037 | 0.89 | (0.09, 1.68) | 0.029 |
| 20MN: University | -0.05 | (-1.49, 1.39) | 0.946 | -0.09 | (-1.71, 1.54) | 0.918 | -0.13 | (-1.15, 0.88) | 0.796 | 0.13 | (-1.00, 1.25) | 0.826 |
| University | 0.22 | (-1.00, 1.43) | 0.726 | 0.26 | (-1.10, 1.62) | 0.703 | 0.03 | (-0.94, 1.01) | 0.945 | 0.49 | (-0.60, 1.57) | 0.379 |
| Hot takeaway outcome | | | | | | | | | | | | |
| 20MN Trade/ Certificate | -0.57 | (-1.70, 0.56) | 0.320 | -0.44 | (-1.73, 0.85) | 0.500 | 0.28 | (-0.53, 1.10) | 0.492 | 0.35 | (-0.58, 1.27) | 0.465 |
| University | -0.25 | (-1.06, 0.55) | 0.542 | 0.03 | (-0.83, 0.90) | 0.937 | 0.18 | (-0.51, 0.88) | 0.607 | 0.18 | (-0.59, 0.95) | 0.650 |
| 20MN:Trade/ Certificate | -0.46 | (-1.24, 0.32) | 0.248 | -0.19 | (-1.05, 0.68) | 0.674 | -0.31 | (-1.05, 0.42) | 0.405 | -0.22 | (-1.03, 0.59) | 0.590 |
| 20MN: University | 0.38 | (-1.09, 1.86) | 0.612 | 0.18 | (-1.53, 1.90) | 0.833 | -0.53 | (-1.57, 0.50) | 0.314 | -0.52 | (-1.66, 0.62) | 0.369 |
| University | 0.33 | (-0.88, 1.54) | 0.591 | 0.17 | (-1.21, 1.54) | 0.812 | -0.27 | (-1.26, 0.72) | 0.597 | -0.28 | (-1.37, 0.80) | 0.610 |

20MN: 20-minute neighbourhood; NH: neighbourhood; SES: socioeconomic status; Coef.: coefficient; CI: confidence interval. *Primary adjustment models adjusted for age, gender, children in the household, relationship status, self-selection [and area-SES in highest qualification models only or highest qualification in area-SES models]. Note that the model output is presented for comparison purposes only and has not been back transformed to obtain odds ratios.

Appendix Table 6. Comparison of covariate-adjusted* models of physical activity for multiple imputed (20 imputed data sets) and complete case data.

| Physical activity survey participants | | | | | | | | |
|---|----------------------------|---------------|----------------------|---------------|----------------------------|---------------|----------------------|---------------|
| Interaction with area-SES | | | | | | | | |
| | Melbourne | | | | Adelaide | | | |
| | Multiple imputation | | Complete case | | Multiple imputation | | Complete case | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| Transport walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| 20MN | 2.97 | (1.22, 7.23) | 0.88 | (0.06, 1.69) | -0.18 | (-0.88, 0.52) | 0.73 | (0.34, 1.55) |
| High NH SES | 1.30 | (0.71, 2.37) | 0.16 | (-0.42, 0.74) | 0.19 | (-0.49, 0.87) | 1.17 | (0.57, 2.40) |
| 20MN:High NH SES | 1.67 | (0.55, 5.11) | 0.74 | (-0.31, 1.79) | 0.94 | (0.00, 1.89) | 3.18 | (1.17, 8.68) |
| Two-part model: minutes of transport walking (if any) | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| 20MN | 0.24 | (-0.09, 0.57) | 0.04 | (-0.28, 0.37) | -0.05 | (-0.37, 0.27) | -0.02 | (-0.39, 0.35) |
| High NH SES | 0.06 | (-0.22, 0.35) | 0.07 | (-0.22, 0.35) | 0.09 | (-0.21, 0.40) | 0.12 | (-0.21, 0.44) |
| 20MN:High NH SES | 0.05 | (-0.35, 0.46) | 0.22 | (-0.18, 0.63) | -0.04 | (-0.45, 0.37) | -0.10 | (-0.56, 0.36) |
| Recreational walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| 20MN | 0.50 | (-0.42, 1.43) | 1.60 | (0.59, 4.32) | -0.45 | (-1.22, 0.32) | 0.58 | (0.26, 1.31) |
| High NH SES | 1.01 | (0.27, 1.75) | 2.32 | (1.08, 4.98) | -0.26 | (-1.08, 0.57) | 0.80 | (0.34, 1.90) |
| 20MN:High NH SES | -1.04 | (-2.28, 0.20) | 0.36 | (0.10, 1.31) | 1.06 | (-0.06, 2.18) | 3.07 | (0.96, 9.83) |
| Two-part model: minutes of recreational walking (if any) | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |

| | | | | | | | | |
|---|----------------------------|---------------|----------------------|---------------|----------------------------|---------------|----------------------|---------------|
| 20MN | -0.20 | (-0.51, 0.12) | -0.25 | (-0.57, 0.08) | -0.13 | (-0.38, 0.12) | -0.04 | (-0.31, 0.23) |
| High NH SES | 0.07 | (-0.17, 0.31) | 0.03 | (-0.22, 0.28) | -0.02 | (-0.25, 0.21) | 0.03 | (-0.21, 0.27) |
| 20MN:High NH SES | 0.17 | (-0.21, 0.56) | 0.22 | (-0.18, 0.62) | 0.29 | (-0.04, 0.61) | 0.16 | (-0.18, 0.50) |
| Number of activities for exercise/recreational physical activity | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| 20MN | 0.01 | (-0.21, 0.23) | -0.01 | (-0.25, 0.22) | 0.01 | (-0.21, 0.23) | -0.10 | (-0.34, 0.15) |
| High NH SES | 0.17 | (0.01, 0.34) | 0.18 | (0.01, 0.35) | 0.07 | (-0.14, 0.28) | 0.01 | (-0.20, 0.23) |
| 20MN:High NH SES | 0.02 | (-0.24, 0.28) | 0.03 | (-0.25, 0.30) | 0.20 | (-0.09, 0.49) | 0.34 | (0.04, 0.65) |
| Interaction with individual-SES | | | | | | | | |
| | Multiple imputation | | Complete case | | Multiple imputation | | Complete case | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| Transport walking | | | | | | | | |
| Two-part model: Any (no/yes) | | | | | | | | |
| 20MN | 1.44 | (-0.02, 2.90) | 3.33 | (0.75, 14.85) | 0.61 | (-0.40, 1.62) | 2.12 | (0.72, 6.23) |
| Trade/ Certificate | -0.31 | (-1.13, 0.50) | 0.65 | (0.28, 1.53) | 0.08 | (-0.75, 0.91) | 1.00 | (0.42, 2.42) |
| University | 0.10 | (-0.59, 0.80) | 1.10 | (0.53, 2.27) | 0.17 | (-0.69, 1.03) | 1.12 | (0.45, 2.78) |
| 20MN:Trade/ Certificate | -0.49 | (-2.32, 1.33) | 1.15 | (0.17, 7.74) | -0.61 | (-1.88, 0.67) | 0.48 | (0.13, 1.87) |
| 20MN: University | -0.03 | (-1.59, 1.52) | 1.28 | (0.26, 6.31) | -0.20 | (-1.40, 0.99) | 0.63 | (0.18, 2.25) |
| Two-part model: minutes of transport walking (if any) | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| 20MN | 0.23 | (-0.26, 0.71) | 0.40 | (-0.10, 0.89) | -0.10 | (-0.53, 0.32) | -0.10 | (-0.55, 0.35) |
| Trade/ Certificate | -0.08 | (-0.51, 0.34) | -0.07 | (-0.50, 0.36) | 0.01 | (-0.37, 0.39) | 0.04 | (-0.37, 0.46) |
| University | -0.20 | (-0.54, 0.13) | -0.24 | (-0.57, 0.10) | 0.09 | (-0.30, 0.48) | 0.09 | (-0.33, 0.51) |
| 20MN:Trade/ Certificate | -0.16 | (-0.84, 0.53) | -0.35 | (-1.04, 0.34) | -0.10 | (-0.64, 0.44) | -0.17 | (-0.75, 0.42) |
| 20MN: University | -0.04 | (-0.56, 0.49) | -0.09 | (-0.62, 0.44) | 0.12 | (-0.38, 0.61) | 0.12 | (-0.41, 0.65) |

| Recreational walking | | | | | | | | |
|---|--------------|----------------|--------------|----------------|--------------|---------------|--------------|---------------|
| Two-part model: Any (no/yes) | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| 20MN | 0.08 | (-1.42, 1.57) | 1.48 | (0.26, 8.45) | -0.66 | (-1.70, 0.38) | 0.41 | (0.13, 1.26) |
| Trade/ Certificate | 0.23 | (-0.68, 1.15) | 1.07 | (0.41, 2.80) | 0.24 | (-0.72, 1.19) | 1.01 | (0.37, 2.79) |
| University | 0.57 | (-0.24, 1.38) | 1.74 | (0.74, 4.10) | 0.01 | (-1.00, 1.02) | 0.80 | (0.27, 2.32) |
| 20MN:Trade/ Certificate | 0.22 | (-1.76, 2.21) | 0.87 | (0.10, 7.81) | 1.02 | (-0.49, 2.53) | 3.22 | (0.67, 15.46) |
| 20MN: University | -0.26 | (-1.93, 1.42) | 0.49 | (0.07, 3.26) | 1.00 | (-0.36, 2.35) | 3.60 | (0.86, 15.10) |
| Two-part model: minutes of recreational walking (if any) | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| 20MN | 0.54 | (0.04, 1.04) | 0.57 | (0.06, 1.08) | -0.10 | (-0.47, 0.27) | 0.01 | (-0.38, 0.41) |
| Trade/ Certificate | 0.38 | (0.05, 0.72) | 0.42 | (0.07, 0.77) | 0.11 | (-0.17, 0.40) | 0.18 | (-0.12, 0.47) |
| University | 0.25 | (-0.04, 0.54) | 0.32 | (0.01, 0.62) | -0.06 | (-0.35, 0.24) | 0.06 | (-0.25, 0.36) |
| 20MN:Trade/ Certificate | -0.60 | (-1.26, 0.05) | -0.71 | (-1.39, -0.03) | 0.06 | (-0.40, 0.51) | -0.02 | (-0.50, 0.46) |
| 20MN: University | -0.75 | (-1.29, -0.21) | -0.78 | (-1.34, -0.23) | 0.25 | (-0.18, 0.68) | 0.10 | (-0.35, 0.56) |
| Number of activities for exercise/recreational physical activity | | | | | | | | |
| | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI | Coef. | 95% CI |
| 20MN | -0.02 | (-0.37, 0.32) | -0.07 | (-0.43, 0.29) | -0.02 | (-0.34, 0.31) | -0.08 | (-0.42, 0.27) |
| Trade/ Certificate | 0.00 | (-0.23, 0.24) | -0.04 | (-0.28, 0.21) | 0.00 | (-0.26, 0.26) | -0.06 | (-0.33, 0.21) |
| University | 0.15 | (-0.05, 0.35) | 0.12 | (-0.09, 0.33) | 0.11 | (-0.15, 0.37) | 0.06 | (-0.21, 0.34) |
| 20MN:Trade/ Certificate | 0.10 | (-0.35, 0.55) | 0.13 | (-0.35, 0.60) | 0.13 | (-0.27, 0.54) | 0.18 | (-0.24, 0.61) |
| 20MN: University | 0.04 | (-0.32, 0.40) | 0.08 | (-0.30, 0.46) | 0.19 | (-0.18, 0.56) | 0.24 | (-0.15, 0.62) |

20MN: 20-minute neighbourhood; NH: neighbourhood; SES: socioeconomic status; Coef.: coefficient; CI: confidence interval. *Primary adjustment models adjusted for age, gender, children in the household, relationship status, self-selection [and area-SES in highest qualification models or highest qualification in

area-SES models]. Note that the model output is presented for comparison purposes only and has not been back transformed to obtain odds ratios, geometric mean ratios and incidence rate ratios.

Appendix Table 7. Comparison of covariate-adjusted* ordinal models of self-rated health for multiple imputed (20 imputed data sets) and complete case data.

| Food survey participants | | | | | | | | | | | | |
|--|----------------------------|---------------|----------|----------------------|----------------|----------|----------------------------|---------------|----------|----------------------|---------------|----------|
| Interaction with area-SES | | | | | | | | | | | | |
| | Melbourne | | | | | | Adelaide | | | | | |
| | Multiple imputation | | | Complete case | | | Multiple imputation | | | Complete case | | |
| | Coef. | 95% CI | p | Coef. | 95% CI | p | Coef. | 95% CI | p | Coef. | 95% CI | p |
| Self-rated health | | | | | | | | | | | | |
| 20MN | -0.07 | (-0.71, 0.57) | 0.826 | -0.06 | (-0.78, 0.67) | 0.880 | -0.45 | (-1.03, 0.14) | 0.133 | -0.43 | (-1.06, 0.21) | 0.186 |
| High NH SES | 0.81 | (0.24, 1.37) | 0.005 | 0.70 | (0.08, 1.31) | 0.026 | 0.96 | (0.40, 1.52) | 0.001 | 1.00 | (0.40, 1.60) | 0.001 |
| 20MN:High NH SES | -0.14 | (-1.00, 0.72) | 0.751 | -0.10 | (-1.05, 0.86) | 0.846 | 0.32 | (-0.46, 1.09) | 0.424 | 0.30 | (-0.53, 1.13) | 0.482 |
| Interaction with individual-SES | | | | | | | | | | | | |
| Self-rated health | | | | | | | | | | | | |
| 20MN | 0.75 | (-0.38, 1.88) | 0.194 | 1.11 | (-0.18, 2.41) | 0.090 | -0.24 | (-1.03, 0.54) | 0.541 | -0.27 | (-1.13, 0.59) | 0.531 |
| Trade/ Certificate | 0.36 | (-0.44, 1.16) | 0.374 | 0.26 | (-0.56, 1.09) | 0.534 | 0.40 | (-0.29, 1.09) | 0.252 | 0.54 | (-0.21, 1.29) | 0.155 |
| University | 0.71 | (-0.06, 1.48) | 0.071 | 0.96 | (0.10, 1.82) | 0.028 | 0.31 | (-0.41, 1.02) | 0.402 | 0.27 | (-0.49, 1.04) | 0.483 |
| 20MN:Trade/ Certificate | -1.09 | (-2.61, 0.43) | 0.160 | -0.89 | (-2.63, 0.85) | 0.318 | -0.22 | (-1.25, 0.81) | 0.673 | -0.17 | (-1.27, 0.94) | 0.770 |
| 20MN: University | -1.15 | (-2.39, 0.10) | 0.071 | -1.74 | (-3.16, -0.32) | 0.017 | 0.07 | (-0.90, 1.05) | 0.882 | 0.12 | (-0.92, 1.16) | 0.818 |
| Physical activity survey participants | | | | | | | | | | | | |
| Interaction with area-SES | | | | | | | | | | | | |
| | Melbourne | | | | | | Adelaide | | | | | |
| | Multiple imputation | | | Complete case | | | Multiple imputation | | | Complete case | | |
| | Coef. | 95% CI | p | Coef. | 95% CI | p | Coef. | 95% CI | p | Coef. | 95% CI | p |
| Self-rated health | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|--|-------|---------------|-------|-------|----------------|-------|-------|---------------|-------|-------|---------------|-------|
| 20MN | -0.10 | (-0.74, 0.55) | 0.768 | -0.02 | (-0.72, 0.67) | 0.945 | -0.46 | (-1.04, 0.12) | 0.123 | -0.43 | (-1.06, 0.21) | 0.186 |
| High NH SES | 0.80 | (0.23, 1.37) | 0.006 | 0.79 | (0.17, 1.41) | 0.013 | 0.96 | (0.39, 1.53) | 0.001 | 1.00 | (0.40, 1.60) | 0.001 |
| 20MN:High NH SES | -0.10 | (-0.97, 0.77) | 0.825 | -0.23 | (-1.16, 0.71) | 0.633 | 0.32 | (-0.45, 1.09) | 0.412 | 0.30 | (-0.53, 1.13) | 0.482 |
| Interaction with individual-SES | | | | | | | | | | | | |
| Self-rated health | | | | | | | | | | | | |
| 20MN | 0.72 | (-0.43, 1.86) | 0.219 | 1.01 | (-0.24, 2.26) | 0.113 | -0.25 | (-1.04, 0.54) | 0.537 | -0.27 | (-1.13, 0.59) | 0.531 |
| Trade/ Certificate | 0.36 | (-0.44, 1.17) | 0.378 | 0.45 | (-0.39, 1.29) | 0.296 | 0.40 | (-0.29, 1.08) | 0.258 | 0.54 | (-0.21, 1.29) | 0.155 |
| University | 0.69 | (-0.09, 1.46) | 0.084 | 0.88 | (0.05, 1.70) | 0.038 | 0.31 | (-0.40, 1.02) | 0.390 | 0.27 | (-0.49, 1.04) | 0.483 |
| 20MN:Trade/ Certificate | -1.07 | (-2.59, 0.45) | 0.169 | -0.97 | (-2.66, 0.73) | 0.262 | -0.23 | (-1.25, 0.80) | 0.661 | -0.17 | (-1.27, 0.94) | 0.770 |
| 20MN: University | -1.10 | (-2.35, 0.15) | 0.085 | -1.56 | (-2.93, -0.18) | 0.027 | 0.07 | (-0.90, 1.05) | 0.882 | 0.12 | (-0.92, 1.16) | 0.818 |

20MN: 20-minute neighbourhood; NH: neighbourhood; SES: socioeconomic status; Coef.: coefficient; CI: confidence interval. *Primary adjustment models adjusted for age, gender, children in the household, relationship status [and area-SES in highest qualification models or highest qualification in area-SES models]. Note that the model output is presented for comparison purposes only and has not been back transformed to obtain odds ratios.