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► To cite this version:

Ruben Brondeel, Rania Wasfi, Camille Perchoux, Basile Chaix, Philippe Gerber, et al.. Is Older Adults' Physical Activity during Transport Compensated during Other Activities? Comparing 4 Study Cohorts Using GPS and Accelerometer Data. *Journal of Transport & Health*, 2019, 12, pp.229–236. 10.1016/j.jth.2019.02.006 . hal-03889730

HAL Id: hal-03889730

<https://hal.sorbonne-universite.fr/hal-03889730v1>

Submitted on 8 Mar 2023

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Is older adults' physical activity during transport compensated during other activities? Comparing 4 study cohorts using GPS and accelerometer data

Authors: Ruben Brondeel ^{a,b,1}, Rania Wasfi ^{a,b}, Camille Perchoux ^c, Basile Chaix ^{d,e}, Philippe Gerber ^c, Lise Gauvin ^{a,b}, Lucie Richard ^{f,h}, Pierrette Gaudreau ^{b,g}, Benoit Thierry ^b, Martin Chevrier ^b, Stine Hoj ^{a,b}, Yan Kestens ^{a,b}

^a Department of Social and Preventive Medicine, École de Santé Publique de l'Université de Montréal (ESPUM), Canada

^b University of Montreal Hospital Research Centre (Centre de recherche du Centre Hospitalier de l'Université de Montréal, CRHUM), Canada

^c Luxembourg Institute of Socio-Economic Research, Esch/Alzette, Luxembourg

^d INSERM, Sorbonne Université, Institut Pierre Louis d'Epidémiologie et de Santé Publique IPLESP, Nemesis team, Paris, France

^f Faculty of Nursing, Université de Montréal, Canada

^g Department of Medicine, Université de Montréal, Canada

^h Institut de recherche en santé publique, Université de Montréal (IRSPUM)

Corresponding author: Ruben Brondeel; ruben.brondeel@ugent.be, Mailing address: Department of Movement and Sports Sciences, Watersportlaan 2, 9000, Gent, Belgium

¹ Present affiliation: Department of Movement and Sports Sciences, Ghent University, Ghent, Belgium - Fund for Scientific Research Flanders (FWO), Belgium

Highlights:

- Older adults with low regular physical activity seemed energized after active trips
- About 14% of additional transport physical activity was compensated the next day
- About 25% of additional transport physical activity was compensated the same day
- Transport intervention evaluations need to evaluate non-transport physical activity

Abstract

Introduction: Promoting active transport offers the potential to increase population physical activity levels. Compensation theories state that above-average physical activity in one activity is compensated in later activities; a mechanism that results in stable levels of total physical activity. Little is known about possible compensation of transport physical activity among older adults.

Methods: GPS (Global Positioning System) and accelerometer data collected among older adults (65+) were pooled from four cohorts in Canada, Luxembourg, and France (n=636, collected between 2012 and 2016). Physical activity was measured as total volume of physical activity for trips and non-trip activities. Robust linear regressions on person-centered data were used to test within-person associations between transport and total physical activity.

Results: 636 older adults – median age of 76 years, 49% women - provided accelerometer and GPS data for at least 4 days. 18% of the total volume of physical activity was related to transport. A positive association was found between physical activity during a trip and the physical activity during the next hour, among those with lower levels of regular physical activity. Negative associations - indicating partial compensation - were found between transport physical activity during a day, and both total physical activity during the next day and non-transport physical activity during the same day. No differences were found between the four study cohorts.

Conclusions: Transport physical activity is compensated partially by older adults during non-transport physical activity. Given the presence of compensation, we strongly recommend evaluations of transport interventions to measure and analyze both non-transport and transport physical activity.

Keywords:

Transport physical activity; Active transport interventions; Accelerometer; Global positioning system; Total volume physical activity; ActivityStat

1. Introduction

Physical activity levels are low and declining worldwide (1; 2), including among older adults (3; 4). This is concerning, given that physical activity appears to favor healthy aging (5), is associated with improved physical functioning and is preventive against non-communicable diseases such as diabetes, depression and certain cancers (6; 5; 7). Promoting active transport offers the potential to increase physical activity levels (8-10), especially among older adults, since few participate in sport and exercise (11). However, increasing active transportation may not translate into greater daily total physical activity (12). Physical activity performed during an active transport episode may later be compensated by reductions in other domains, such as leisure-time activity, nullifying gains in total physical activity. A recent Canadian study showed increasing participation in leisure-time activities and active transportation across five 10-year age cohorts between 1994 and 2010, while daily physical activity (e.g. household activities) decreased (13). Younger adults were more involved in leisure-time activities and active transport, but also reported less daily physical activity compared to older adults (13).

The 'ActivityStat' hypothesis – a commonly cited compensation theory – argues that compensation is driven by a biological mechanism which ensures a constant level of physical activity or energy expenditure over a certain period of time (14). Under this hypothesis, a period of increased physical activity will be followed by a period of lower than average physical activity. Similarly, a period of low physical activity will be followed by a period of greater than average physical activity. Under this hypothesis, a given level of transport-related physical activity (higher/lower) would subsequently be compensated by reductions in other activities (lower/higher) (e.g., leisure-time, occupational) or in so-called spontaneous physical activity (e.g., fidgeting) to maintain a 'constant' level of physical activity or energy expenditure. Note that the timeframe for compensation to occur is not well-defined in the ActivityStat theory (15).

In opposition to compensation hypotheses, 'Generalization' (16) hypotheses, also known as 'Performance' (17) or 'Synergy' (18) hypotheses, predict that the performance of additional physical activity in one domain will subsequently lead to increases in physical activity in other domains. Intermediate mechanisms may relate to a feeling of being energized (short-term generalization) or the translation of increased physical fitness into greater total physical activity (long-term generalization).

36 Finally, the 'Independence' or 'Additive' hypothesis, which is predominant in the literature but
37 usually not explicitly stated (17), purports that an increase in physical activity (e.g. during
38 transport) is not related to the physical activity during other activities. This means there is
39 neither compensation nor generalization. This hypothesis is implicit in studies evaluating
40 intervention effects on active transport behavior alone, without assessing the effect on total
41 physical activity. In this article, the 'Compensation' and 'Generalization' mechanisms are
42 considered antipodes, with a lack of either mechanism suggesting 'Independence'.

43

44 The 'Compensation / Generalization' hypotheses have mainly been tested in relation to
45 exercise physical activity (15). A 2013 review (15) identified 28 experimental studies
46 investigating the 'ActivityStat' hypothesis following the introduction of exercise interventions.
47 Results were mixed, with fifteen studies detecting some compensation, and thirteen
48 identifying none. From the few studies among older populations, there was somewhat
49 greater support for the compensation hypothesis (4 out of 5 studies). A similar review
50 concluded that there was no compelling evidence to support either the Compensation or the
51 Generalization hypothesis (19). Interestingly, they noted that the studies with some evidence
52 of compensation were conducted among significantly older adults (median age of 61 years)
53 than those that found no evidence of compensation (median age of 44 years).

54

55 Very few studies have investigated compensation / generalization in relation to transport
56 physical activity, and those that have rely upon self-reported physical activity. Two
57 longitudinal UK-based studies of 469 and 1628 adults found no evidence of compensation or
58 generalization in relation to changes in transport-related physical activity over time (12; 20).
59 A cross-sectional study found a positive association between transport-related physical
60 activity and total physical activity, appearing to suggest an absence of compensation of
61 transport physical activity (21). However, the study does not permit the identification of
62 possible partial compensation, independence or generalization mechanisms. In order to
63 further our understanding of these processes in relation to transport physical activity, there is
64 a need to obtain objective measures of physical activity and to decompose total daily
65 physical activity into specific episodes (e.g. transport vs. non-transport episodes). To our
66 knowledge, only one study has used GPS-based recognition of activity locations in
67 combination with accelerometer data to test the 'Compensation / Generalization' hypotheses
68 (16). Analyzing data from 528 school-going adolescents, there was no evidence of
69 compensation in moderate-to-vigorous physical activity between different activity locations
70 (home, home neighborhood, school, school neighborhood, and other locations). However,
71 this study did not analyze transport behavior specifically.

72

73 In summary, no study has explored possible compensation / generalization processes in
74 relation to transport physical activity using objective measures. Moreover, there is no
75 evidence (using objective or self-reported data) to support or refute such processes among
76 older adults. This is despite the fact that exercise research suggests compensation may be
77 age dependent, with older adults seemingly more likely to compensate physical activity than
78 children or younger adults (17).

79

80 To address these current gaps in the literature, this study assesses the association between
81 transport, non-transport, and total physical activity levels, using GPS and accelerometer data
82 obtained from older adults in Canada, Luxembourg and France. Compensation and
83 generalization hypotheses were assessed by testing associations between objectively
84 measured physical activity: i) during a given transport episode and during the hour following
85 that episode, ii) during transport episodes on one day and during the entire next day, and iii)
86 during transport episodes and non-transport periods within the same day. The first two
87 associations test whether compensation occurs subsequent to periods of above or below
88 average physical activity. The third hypothesis considers compensation within the same day,
89 allowing compensation to occur before (pre-compensation) and not only after (post-
90 compensation) a given activity. Pre-compensation could be linked to activity planning; for
91 instance, people might engage in lower levels of non-transport physical activity in
92 anticipation of active transport activities during the same day. Considering the large
93 differences in physical functioning between early retirees and older retirees (3), each model
94 tested the dependency of compensation on age, study cohort, and mean daily physical
95 activity.

96

97 **2. Methods**

98 *2.1. Participants*

99 The study uses 7-day GPS and accelerometer data collected among older adults in Canada,
100 Luxembourg and France. Participants were pooled from the CURHA (Contrasted URban
101 settings for Healthy Aging) (22), RECORD (Residential Environment and CORonary heart
102 Disease) (23), and PACTE-ROSEMONT (Participation sociale, ACTivité physique et
103 Environnement bâti) study cohorts

104 The 636 CURHA study participants used for this analysis included i) 148 participants from
105 Montreal and Sherbrooke area, Canada, recruited among the pre-existing Quebec
106 Longitudinal Study on Nutrition and Successful Aging (NuAge) cohort (24) and followed
107 during the Autumn 2014 or Spring 2015; and ii) 319 participants from Luxembourg, recruited

108 in 2015-2016 among a representative random sample of the Luxembourgish Social Security
109 files, and stratified by age, gender and five spatial strata. 94 participants residing in the Paris
110 Region, France, were drawn from the RECORD GPS (25; 26) and RECORD MultiSensor
111 studies (27) recruited in 2012-2013 and 2014-2015, respectively. Finally, data were used
112 from the first wave of the PACTE-Rosemont study conducted in autumn 2016 (n = 75). The
113 PACTE-Rosemont study is a longitudinal study of older adults with 6 planned waves of data
114 collection (2016-2019) taking place in Rosemont, a central borough of Montreal.

115

116 The RECORD sample was approved by the French Data Protection Authority; the
117 Luxembourg CURHA sample by the 'Commission Nationale de la Protection des Données'
118 (CNPD, #408/2017); and the PACTE-Rosemont and Canadian CURHA samples by the
119 'Comité d'Éthique de la Recherche of the Centre de Recherche du Centre Hospitalier de
120 l'Université de Montréal' (CRCHUM, #13.073 and #15.355). All participants signed an
121 informed consent form prior to participation.

122

123 Participants were instructed to wear devices with GPS and accelerometer capabilities at the
124 right hip for 7 consecutive days, from wake-up to bed time. CURHA and PACTE-Rosemont
125 participants wore the SenseDoc 2.0 (Mobysens Technologies) device – which includes a
126 GPS receiver and a tri-accelerometer. RECORD participants wore a BT-Q1000XT (QStarz)
127 for GPS tracking and a wGT3X+ accelerometer (ActiGraph).

128

129 *2.2. Data*

130 Start and end times of visits (stay at a location, e.g. residence) and trips were extracted from
131 the GPS tracks using a kernel-based algorithm (28). Transport versus non-transport time
132 was linked to the accelerometer data through timestamps.

133

134 Raw accelerometer data in gravitational units were extracted from the SenseDoc and
135 ActiGraph devices using SenseAnalytics (version 1.9) and ActiLife (version 6). The raw data
136 were then converted into activity counts in MATLAB (version R2017a) using a documented
137 algorithm to calculate commonly used ActiGraph activity counts with data from Actigraph
138 devices and other devices with the same accelerometer-chip (29). Non-wear time of the
139 devices was defined as 90 min of consecutive zero activity counts, allowing for 2 minutes of
140 non-zero counts (30). Observation days with less than 10 hours wear time (i.e. non-valid
141 days) were excluded, and participants with less than 4 valid days were completely excluded.
142 Additional material S1 provides full details about the devices and the processing of raw GPS
143 and accelerometer data.

144

145 Physical activity was measured as the total volume of physical activity, i.e. the sum of the
146 vector magnitude of activity counts. The vector magnitude counts were calculated per
147 second as the square root of the sum of the counts on the three axes. Physical activity
148 measures were computed per trip and per day.

149

150 2.3. Analyses

151 The compensation hypothesis was tested in 3 separate models assessing potential
152 compensation processes in different time frames. We analyzed the associations between
153 *'Physical activity during a trip'* and *'Physical activity during the hour following the trip'* (Model
154 1, observation: trip); *'Transport-related physical activity during a day'* and *'Total physical
155 activity during the next day'* (Model 2, observation: day); and *'Transport-related physical
156 activity during a day'* and *'Non-transport physical activity during the same day'* (Model 3:
157 observation: day). Because these associations may by themselves be dependent on
158 participants' overall physical functioning, the interactions with participants' *'Mean daily
159 physical activity'* were further tested. In all models, the interaction term between trip-related
160 physical activity and *'Age'* (in years) and *'Study Cohort'* (4 categories) were tested. Model 1
161 was controlled for *'Time of day at arrival'* (6 categories: 3am-9am, 9am-12pm, 12pm-3pm,
162 3pm-6pm, 6pm-9pm, 9pm-3am); Model 2 and Model 3 were controlled for *'Weekday'* (7
163 categories).

164

165 To facilitate comparison with previous papers, physical activity intensity measures were
166 included in the descriptive analyses. We used cut-points based on the vector magnitude
167 counts per 15 seconds, developed for older adults (31): moderate-to-vigorous physical
168 activity (MVPA: $vm = [519; +\infty[$), high-light physical activity (HLPA: $vm = [226; 519[$), low-light
169 physical activity (LLPA: $vm = [19; 226[$), and physical inactivity (PI: $vm = [0; 19[$, also known
170 as sedentary behavior).

171

172 All regression analyses were performed on person-centered physical activity measures, i.e.
173 the person-mean was subtracted from the measures. Subtracting the personal mean from a
174 measure removes between-person variance, enabling estimating strictly within-person
175 associations. The results indicated if trips with above average physical activity were followed
176 by non-travel episodes with above (or below) average physical activity. The results did NOT
177 indicate if persons engaging in more active travel (e.g. a regular biker), also engaged in
178 more non-transport related activity, compared to people engaging in less in active travel.
179 Even though these between-person associations could be interesting by themselves for
180 other research questions, they would potentially confound the findings on the compensation
181 of transport physical activity. Carlson et al. (16) applied this method to investigate the

182 compensation of physical activity between different locations adolescents frequent. Other
 183 studies used a difference score as the dependent variable to study compensation over time
 184 (20) which is identical to the person-centered approach in the context of only 2 time points
 185 for each person. In our study, we used each trip (or each day, depending the model) as a
 186 different time point, so the difference score method was not applicable. Another approach
 187 would be limited the between-person variability by using a randomized study design in a
 188 controlled setting.

189
 190 Preliminary analyses revealed that both the outcome variables and the residuals had a
 191 normal-like distribution, but with presence of extreme values. To obtain reliable confidence
 192 intervals, we used robust linear regressions within the 'robust' package in R (32).

193 3. Results

194 From the 752 older adults providing any accelerometer and GPS data, 636 participants
 195 provided 10 hours of valid data during at least 4 days. The median age was 76 years old
 196 (interquartile range (IQR): 70 - 82), and 49% were women. During valid days, participants
 197 wore the sensors on average 13h31 min, of which 1h10 min was during transport.

198 Descriptive statistics per study cohort are provided in Table 1.

199
 200 Table1. Age and Gender distributions for total sample and by study cohort.

| | Number of participants in analyses | % of total participants | Age in years Median (IQR) | Gender (% Women) |
|--------------------|------------------------------------|-------------------------|---------------------------|------------------|
| Total | 636 | 85 % | 76 (70; 82) | 49 % |
| CURHA – Canada | 148 | 88 % | 83 (81; 87) | 52 % |
| CURHA – Luxembourg | 319 | 81 % | 76 (71; 81) | 49 % |
| QADA – Canada | 75 | 82 % | 71 (68; 75) | 68 % |
| RECORD – France | 94 | 96 % | 70 (67; 73) | 31 % |

201 Statistics on Age and Gender are calculated for the participants in the analysis only. Participants were excluded if
 202 they did not provide at least 4 valid days of accelerometer and GPS data. Valid days were determined on at least
 203 10 h of wear time. Data collected in four cohorts in Canada, Luxembourg, and France between 2012 and 2016.
 204

205 On average, 480,000 activity counts per day were recorded during transport, corresponding
 206 to 21% of the total daily physical activity (Table 2). 23% of MVPA, 12% of HLPa, 17% of
 207 LLPA (25 min), and 14% of physical inactive time per day was spent during transport.

208
 209 Table 2. Daily total, transport and non-transport physical activity levels across 5 indicators

| | TVPA (/1000) | | MVPA (min) | | HLPV (min) | | LLPA (min) | | PI (min) | |
|--------------------------------|-----------------|-------------------|---------------|-----------------|---------------|-----------------|---------------|-------------------|--------------|-------------------|
| | Mean (sd) | Median (IQR) | Mean (sd) | Median (IQR) | Mean (sd) | Median (IQR) | Mean (sd) | Median (IQR) | Mean (sd) | Median (IQR) |
| Total (per day) | 408 (224) | 357 (253; 512) | 65 (48) | 54 (29; 90) | 94 (40) | 88 (65; 116) | 156 (54) | 150 (118; 188) | 497 (120) | 498 (414; 578) |
| Transport (per day) | 84 (130) | 33 (4; 113) | 15 (25) | 5 (0; 20) | 11 (20) | 3 (0; 14) | 26 (34) | 15 (2; 37) | 72 (108) | 29 (2; 91) |
| Non- Transport (per day) | 312 (191) | 279 (186; 401) | 48 (40) | 38 (19; 65) | 79 (42) | 76 (50; 103) | 124 (58) | 122 (85; 160) | 407 (160) | 421 (315; 518) |

210 TVPA = Total volume physical activity; MVPA = moderate-to-vigorous physical activity; HLPV = high-light
211 physical activity; LLPA = low-light physical activity; PI = physically inactive time (also referred to as sedentary
212 behavior); sd = standard deviation; IQR = interquartile range. Sample size = 3899 days from 636 persons. Data
213 collected in four cohorts in Canada, Luxembourg, and France between 2012 and 2016.

214

215

216 Model 1 (Table 3) analyzed within-person associations of *'physical activity during a trip'* and
217 *'physical activity during the next hour'*. The results indicated that for people with low *'Mean*
218 *daily physical activity'*, there was a positive association between *'Physical activity during a*
219 *trip'* and *'Physical activity during the following hour'*, whereas for people with high *Mean daily*
220 *physical activity'*, the relation was negative to non-existent. Figure 1 illustrates the interaction
221 by presenting the association for the lower 1st decile and top 9th decile in mean physical
222 activity.

223

224 Table 3. Within-person associations between transport and total physical activity using
225 robust linear regression

| | Model 1 - TVPA during following hour Estimate [95% CI] | Model 2 - TVPA during next day Estimate [95% CI] | Model 3 - Non-transport TVPA same day Estimate [95% CI] |
|-------------------------------------|---|---|--|
| TVPA during trip | 16.76 [3.16; 30.36] | - | - |
| Transport TVPA per day ^a | - | -136.82 [-188.12; -85.52] | -245.52 [-286.23; -204.8] |
| Mean daily TVPA | -19.57 [-22; -17.13] | -9.61 [-29.9; 10.67] | -14.16 [-30.22; 1.89] |

| | | | |
|--|--------------------------------|----------------------------|------------------------|
| TVPA during trip ^a * Mean Daily TVPA ^a | -0.12 [-0.16; -0.07] | - | |
| Transport TVPA * Mean daily TVPA ^a | - | -0.08 [-0.26; 0.11] | 0 [-0.14; 0.15] |
| (Intercept) | 1861 [631; 3090] | -20318 [-29820; -10817] | 6292 [-1054; 13637] |

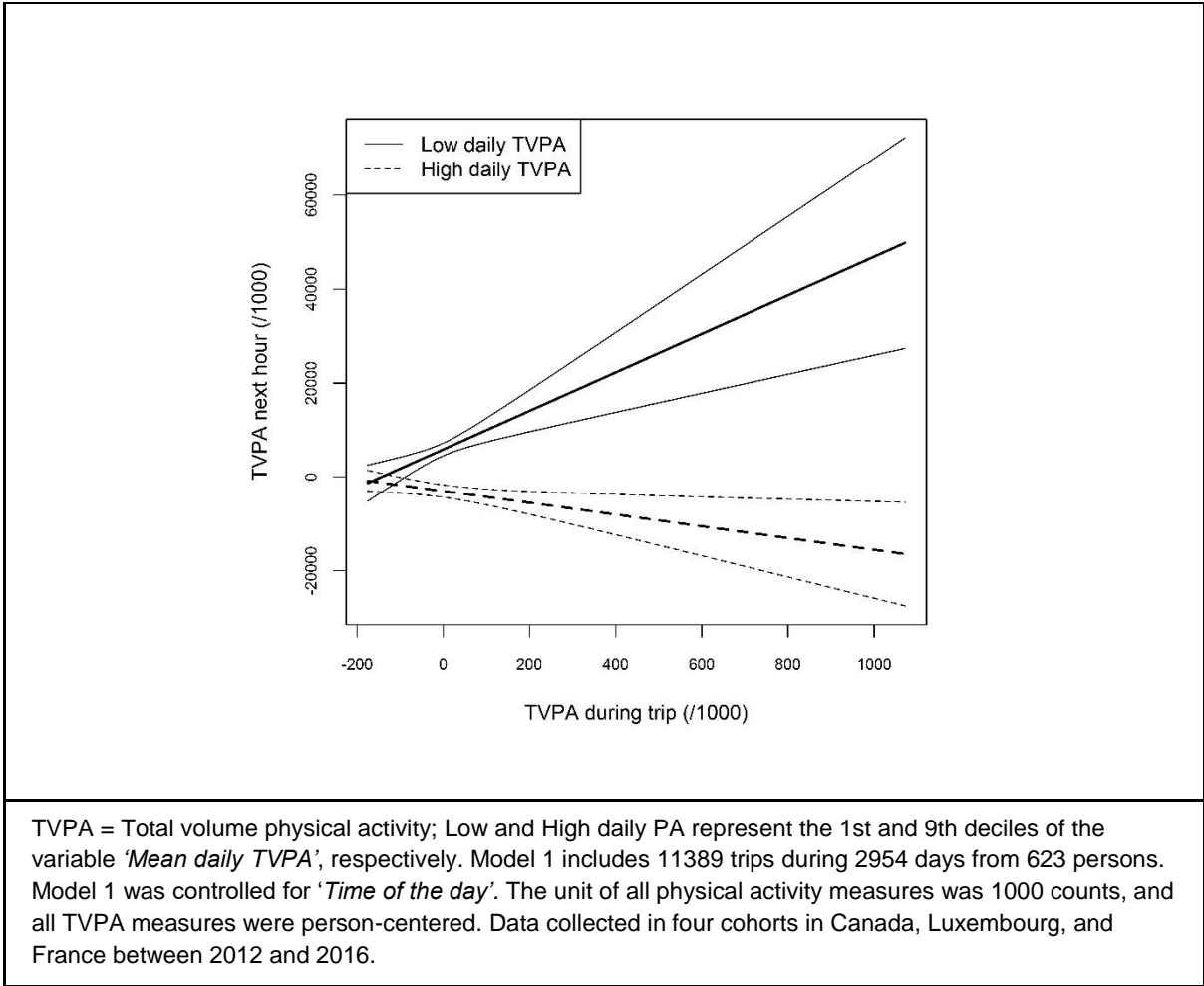
226 Model 1 includes 11389 trips during 2854 days from 623 persons, Model 2 includes 3410 days from 636 persons,
227 and Model 3 includes 3899 days from 636 persons. The differences in numbers resulted from a lack of trips
228 during a day (model 1), or because the next day was not observed (model 2). Model 1 was controlled for 'Time of
229 the day', model 2 and 3 controlled for 'Weekday'. Interaction terms between 'Transport physical activity' and both
230 'Age' and 'Study' were tested; and the interaction term 'Study' was withheld. ^a The unit of the independent
231 physical activity measures was 1000 counts to facilitate the reading of the tables. TVPA = Total volume physical
232 activity; Ref. cat. = Reference category; 95% CI = 95% confidence interval. Data collected in four cohorts in
233 Canada, Luxembourg, and France between 2012 and 2016.

234
235 Model 2 (Table 3) analyzed within-person associations of '*transport-related physical activity*
236 *during a day*' and '*total physical activity during the next day*'. For people with an average
237 level of '*Mean daily physical activity*', a day with 1000 counts above average during transport
238 was associated with 137 counts (95% CI: -188; -86) below average the following day,
239 suggesting a small compensation of transport-related physical activity. This association was
240 not modified by the level of '*Mean daily physical activity*'.

241
242 Finally, Model 3 analyzed within-person and within-day associations of '*transport-related*
243 *physical activity*' and '*non-transport physical activity*'. For people with an average level of
244 '*Mean daily physical activity*', 1000 counts above average during transport was related to
245 246 counts below average during non-transport activities (95% CI: -286; -205). The
246 association was not modified by the level of '*Mean daily physical activity*'.

247

Figure 1. The association between 'Physical activity during 1 hour after a trip' and 'Physical Activity during a trip' for two levels of 'Mean Daily Physical Activity' (Model 1) - slopes and 95% confidence bands



248

249 **4. Discussion**

250 Promoting active transport is a promising means to improve older adults' physical activity
 251 levels, but, the evaluation of the expected benefits, requires knowledge of whether
 252 compensation occurs during other activities. Using GPS and accelerometer data from older
 253 adults in three countries, we analyzed within-person associations between transport physical
 254 activity and total physical activity to detect evidence of compensation across three time
 255 frames: within the next hour, within the same day, or during the following day. Results
 256 showed that net gains in transport physical activity translated into net gains in total physical
 257 activity. However, partial compensation was also observed, such that the total physical
 258 activity gain was somewhat smaller than the gain in transport physical activity. Evidence for
 259 compensation differed according to the time frame under consideration as well as
 260 participants fitness levels as indicated by their mean daily physical activity.
 261

262 In the context of the transport behavior of older adults, we found little to no evidence of
263 compensation in the hour following a trip (Model 1). For participants with lower levels of daily
264 physical activity, there was even evidence of generalization – i.e. increased physical activity
265 during the following hour. This suggests that transportation episodes might energize some of
266 the older adults for a short period of time. By contrast, the observation of partial
267 compensation within the full day (Model 3) and even the following day (Model 2) indicates
268 that the energizing effect is only part of the picture.

269

270 Transport physical activity translated in a higher net gain of total physical activity for older
271 adults with low levels of mean daily physical activity (Model 1). This finding resonates with
272 the ‘Constrained Total Energy Expenditure’ theory, which states that there is a ceiling to
273 improving energy expenditure levels (17; 33). While it is relatively easy for people with low
274 energy expenditure to achieve marginal increases in energy expenditure, it is naturally more
275 difficult for people whose level of energy expenditure is already high. Even though there is
276 no perfectly linear relation between physical activity and energy expenditure, the results
277 indicate there might be a similar ceiling effect in physical activity. People with low levels of
278 physical activity might be able to increase their physical activity levels more easily compared
279 to people with already high levels of physical activity. People with high levels of physical
280 activity might therefore be more likely to compensate additional transport physical activity.

281

282 Higher levels of transport physical activity were partially compensated by lower levels of
283 non-transport physical activity during the same day (Model 3). Specifically, an increase of
284 100 counts in transport-related physical activity was related to a decrease of 25 counts (95%
285 CI: 20; 29) in non-transport physical activity during the same day. This indicates there was
286 some compensation of transport physical activity during the same day, large enough to be
287 meaningful for active transport interventions. This finding could reflect time limitations,
288 whereby the time-consuming nature of active transport prevents older adults from engaging
289 in other activities during that day. Alternatively, older adults might anticipate active transport
290 by being less active earlier during the day (for example, delaying household work). Future
291 research is needed to clarify the contradiction of compensation during the same day, and no
292 or hardly any compensation during the time following active transport.

293

294 Interestingly, we did not observe any difference between study cohorts. For all models, an
295 interaction term between transport physical activity and study cohort was tested. Despite
296 overall differences in physical activity levels between the studies (supplementary material
297 S2), there were no meaningful or statistical significant differences between the four study
298 cohorts in terms of compensation or generalization of transport physical activity.

299

300 A major strength of this study was the unique data set, which included objective
301 accelerometer and GPS data from a large number of older adults (n = 636) residing in
302 Canada, Luxembourg and France. Datasets with objective measures of both transport
303 behavior and physical activity are often small, due to technical difficulties in measuring
304 detailed transport behavior. A limitation to this approach is the comparability of sensors and
305 how they are worn between studies. In this study, the sensors were worn the same (right
306 hip) and the raw data was processed by the same algorithms. Also the technical aspects of
307 the SenseDoc (integrated GPS and accelerometer), and the Qstarz (GPS) combined with
308 the ActiGraph (accelerometer) were very comparable (supplementary material S1).
309 However, we cannot exclude that the accumulation of small differences in the devices might
310 still have had some influence on the results. A second strength was the within-person
311 analyses, which enabled comparing physical activity levels during trips and days within a
312 person. This method corresponds well with a longitudinal design to measure within-person
313 changes, compared to analyses on interpersonal differences. However, a data set with a
314 longer observation period would have arguably been better to analyze compensation
315 behavior, since there is no consensus on the time frame in which compensation potentially
316 occurs (15). Ideally, the observation period should also include a transport intervention, so
317 that changes in transport and non-transport physical activity could be causally linked to the
318 intervention.

319

320

321 **5. Conclusion**

322 Transport and other urban interventions are important to promote physically activity, also
323 among older adults. However, evaluating the impact of interventions by measuring transport
324 physical activity only - and not total physical activity - can be problematic. Possible
325 compensation of transport physical activity during non-transport time should be considered
326 in public health studies analyzing the possible increase in physical activity levels through
327 active transport or other activities. The results of this study indicated that for older adults in
328 Canada, Luxembourg and France, there was little to no compensation of transport physical
329 activity during subsequent physical activity, indicating there might be no biological ground for
330 compensation related to transport physical activity. For people with low average levels of
331 physical activity, there was even some evidence of a short-term energizing effect of active
332 transport for older adults with less regular physical activity. However, the results also
333 indicated meaningful lower levels of non-transport physical activity during a day with above
334 average transport physical activity, about 25% of transport-related physical activity

335 compensated during non-transport activities. These findings suggest that compensation may
336 be a result of planning or anticipation, rather than a biological response to high levels of
337 transport physical activity. Even though there is not a complete compensation of transport
338 physical activity by older adults, we strongly recommend active transport intervention
339 evaluations to measure and analyze total physical activity along with the active transport.
340
341

342 **Acknowledgements**

343 The recruitment of the NuAge cohort participants for the CUHRA project was made possible
344 through a funding of the Pfizer-Fonds de recherche du Québec-Santé (FRQS) Innovation
345 Fund for Alzheimer's Disease and Related Disorders. The NuAge cohort platform is
346 supported by the Quebec Network for Research on Aging, a thematic network funded by the
347 FRQS. The CURHA project (Contrasting Urban Environments and Healthy Ageing: The
348 International Longitudinal CURHA Study) is an international study conducted in Luxembourg
349 (LISER – Luxembourg Institute of Socio-Economic Research), Canada (CRCHUM – Centre
350 de Recherche du Centre Hospitalier de l'Université de Montréal) and France (INSERM –
351 Institut National de la Santé et de la Recherche Médicale). It is cofounded by FNR (Fonds
352 National de la Recherche, INTER/JCRA/12/6542889), IRSC (Instituts de Recherche en
353 Santé Canada TEA-124969), and FRSQ (Fonds de Recherche du Québec, #28837). YK
354 holds a CIHR Chair in Urban Interventions and Population Health. We are grateful to the
355 people from the Survey Team at LISER.

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