Examining the possible impact of daily transport on depression among older adults using an agent-based model

Yong Yang [1], Brent A. Langellier [2], Ivana Stankov [3] , Jonathan Purtle [2], Katherine L. Nelson [2], Ana V. Diez Roux [3]

AFFILIATIONS

[1] School of Public Health, University of Memphis

[2] Department of Health Management and Policy, Dornsife School of Public Health, Drexel University

[3] Urban Health Collaborative, Dornsife School of Public Health, Drexel University

Corresponding author:

Yong Yang

Yyang15@memphis.edu

339 Robison Hall

School of Public Health, University of Memphis

Memphis, TN, 38152

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3 Abstract

4 Objectives: Daily transport may impact depression risk among older adults through several
5 pathways including facilitating the ability to meet basic needs, enabling and promoting contact with other
6 people and nature, and promoting physical activity (e.g. through active transportation such as walking or
7 walking to public transit). Both daily transport and depression are influenced by the neighborhood
8 environment. To provide insights into how transport interventions may affect depression in older adults,
9 we developed a pilot agent-based model to explore the contribution of daily transport and neighborhood
10 environment to older adults' depression in urban areas.

11 Method: The model includes about 18,500 older adults (i.e., agents) between the ages of 65 and
12 85 years old, living in a hypothetical city. The city has a grid space with a number of neighborhoods and
13 locations. Key dynamic processes in the model include aging, daily transport use and feedbacks, and the
14 development of depression. Key parameters were derived from US data sources. The model was
15 validated using empirical studies.

16 Results: An intervention that combines a decrease in bus fares, shorter bus waiting times, and
17 more bus lines and stations is most effective at reducing depression. Lower income groups are likely to be
18 more sensitive to the public transit-oriented intervention.

19 Conclusion: Preliminary results suggest that promoting public transit use may be a promising
20 strategy to increase daily transport and decrease depression. Our results may have implications for
21 transportation policies and interventions to prevent depression in older adults.

22 Keywords

23 Depression, older adults, agent-based model, daily transport, aging

24 Funding

29 Disclosure statement

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30

1. Introduction

Mental health is a particular concern of the growing aging population living in cities across the world (Beard & Bloom, 2015; Reynolds et al., 2012). Older adults are at an increased risk of clinically significant depressive symptoms (World Health Organization, 2013). In interaction with other health issues including comorbid physical health problems and physical disability (Fiske, Wetherell, & Gatz, 2009; J. Katon, 2011), depression may have more serious consequences in older adults than in younger groups. Depression risk among older adults is influenced by factors at the individual (e.g., physical activity, income), interpersonal (e.g., loneliness, social support), neighborhood (e.g., access to green space), health care system, and societal (e.g., stigma) levels (Martin G. Cole & Nandini Dendukuri, 2003). An important factor that may influence depression risk among the elderly and that is amenable to public policy is daily transport (Choi & DiNitto, 2016), defined as both active (e.g., walking) and passive (e.g., car, bus) transportation. Similar to the general population, older adults' daily transport is associated with household income, driver status, car ownership and household vehicle count (Pucher, Buehler, Merom, & Bauman, 2011; Pucher & Renne, 2003). However, compared to younger populations, older adults tend to take fewer trips, travel shorter distances, have smaller activity zones, and engage in a larger share of non-work trips. Furthermore, this decrease in daily transport activities is even more pronounced in older women and older adults with medical conditions (Collia, Sharp, & Giesbrecht, 2003; Horner, Duncan, Wood, Valdez-Torres, & Stansbury, 2015).

Daily transport may impact depression risk and other mental health outcomes among older adults through several pathways. First, daily transport is indispensable to meet most basic needs (e.g., grocery shopping, access to health care services), and the failure to meet basic needs as a result of unmet daily transport may increase the risk of depression among older adults (Choi & DiNitto, 2016). Second, daily transport enables and promotes contact with other people and nature, which have positive effects on overall mental health and wellbeing (Kawachi & Berkman, 2001; Ulrich et al., 1991). Older adults with limited daily transport are more likely to live in isolation and thus less likely to participate in meaningful social and cultural activities and maintain supportive social networks (Musselwhite, Holland, & Walker, 2015). Additionally, as a source of physical activity, active transportation has a protective effect on mental health and depression (Barbour & Blumenthal, 2005; De Mello et al., 2013; Mammen & Faulkner, 2013). Transitions from a physically active state to an inactive one, which are increasingly common as older adults age, are associated with major depressive episodes (Patten, Williams, Lavorato, & Eliasziw, 2009).

Daily transport and depression are both influenced by the neighborhood environment (Julien, Richard, Gauvin, & Kestens, 2012; Rosso, Auchincloss, & Michael, 2011). Neighborhood characteristics influence older adult's overall level of mobility as well as the types of travel modes they use most frequently (e.g., walking, cycling, public transit) (Rosso et al., 2011; Saelens & Handy, 2008; Winters, Brauer, Setton, & Teschke, 2010). Compared with younger adults, older adults' daily transport may be more impacted by the neighborhood environment because of increased time spent in their neighborhoods (Glass & Balfour, 2003). Furthermore, cognitive and physical constraints may make older adults more sensitive to certain environmental factors (e.g., poorly maintained sidewalks or lack of street

crosswalks may be barriers to walking). In addition, neighborhood characteristics such as neighborhood crime, unsafe traffic, social cohesion and access to recreational facilities may be associated with depression independent of transportation and walkability (Elliott, Gale, Parsons, Kuh, & Team, 2014; Ivey et al., 2015; Julien et al., 2012; Mair, Roux, & Galea, 2008; Richardson, Westley, Gariépy, Austin, & Nandi, 2015). Overall, older adults may be more vulnerable to neighborhood factors than younger adults.

Policies that promote public transport use may increase both daily transport and overall physical activity among older adults. Despite longer durations than automobile trips, public transport use has a number of benefits (e.g., free time on board, and reduced gasoline consumption, congestion, and land for parking) and may be the only feasible option for older adults who are more likely to have a driving limitation. Walking is probably the most common mode for accessing the public transit. An inability to safely walk from home to a nearby transit stop has been reported as a significant barrier to public transportation ridership among older people (Hess, 2009). Thus walking-friendly environments, especially in the vicinity of transit stops and stations are critical for both daily transport and physical activity.

The neighborhood environment, daily transport, and depression are interrelated. These interrelations may involve feedbacks, dependencies, and conditional effects. Understanding the impact of policies may require understanding these dynamic relationships. Agent-based modeling (ABM) has gained increasing attention in public health because it captures the dynamic interactions between multi-level factors and accounts for feedback mechanisms among individuals and between individuals and their environment (Luke & Stamatakis, 2012; Nianogo & Arah, 2015). A small number of ABMs have been used to examine mental health issues (Cerda, Tracy, Keyes, & Galea, 2015; Kalton et al., 2016; Lyon, Maras, Pate, Igusa, & Stoep, 2016; Stephen J. Mooney & Abdulrahman M. El-Sayed, 2016). However, to our knowledge, only one study has used ABM to explore social determinants of depression, focusing on the role that an individual's body weight, social norms, and social isolation play in shaping depression risk (S. J. Mooney & A. M. El-Sayed, 2016). No studies have used ABM to assess the role that daily transport or physical activity play in shaping mental health.

We developed a pilot ABM to explore the contribution of daily transport and the neighborhood environment on older adults' depression in urban areas. The primary research aim was to examine the possible influence of policies seeking to improve both public transportation and the walkability of neighborhood environments on depression prevalence among older adults.

2. Methods

2.1. Model overview

The ABM includes about 18,400 agents, each representing an older adult between 65 and 85 years old living in a hypothetical city. People older than 85 were excluded because the empirical data sources used for model development generally did not include data on this age group. The model runs in discrete time with each time step representing one year. The ABM explicitly incorporates dynamic processes including aging, transport use, and depression development (Figure 1). The ABM was adapted from two previously published models (Yang et al., 2015; Yang, Diez Roux, Auchincloss, Rodriguez, &

Brown, 2011) and developed using Java and Repast (a free and open-source agent-based modeling and simulation toolkit) ("The Repast Suite," 2017).

The model environment represents a city of 64 km^2 (8 km by 8 km) with an 800*800 grid space, where each cell of size 10 m*10 m is either occupied by a location or is empty. The location can be a residence, a location for basic needs (e.g. shop), or a location for social activities (e.g. social place, restaurant, or bar). Figure 2 shows the spatial display of the hypothetical city. The city has 400 equally-sized neighborhoods, each composed of 40*40 cells. Each neighborhood is assigned three variables including safety (e.g. neighborhood crime levels), walkability (here defined as pedestrian friendliness), and environmental depression risk (EDR). We defined EDR as a variable that represents all unmeasured dimensions of a neighborhood that are likely to impact depression risk (e.g., neighborhood social cohesion, green space, aesthetic, blight) that are not captured in the safety and walkability variables. The value of each neighborhood variable ranges between 0 and 1, wherein 1 indicates the based on the safest for safety, the most walking friendly for walkability, and the lowest depression risk for EDR. The city has a symmetrical public transport network. Three east-west bus lines and three north-south bus lines cross each other with 2 km distances between bus lines. Each bus route covers 4 km with bus stops at 400-meter intervals, consistent with US data (distances between bus stops in the range of 200-600 meters (Ammons, 2001)). Altogether the city center has 57 bus stops. There is no public transport network outside of the city center.

Each time step (one year), 1,000 older adults of age 65 years (as 500 households, each with one male and one female) enter the model. For simplicity, the model is initialized with an equal proportion of males and females. However, during the course of the simulation and as a result of the empirically-informed mortality rates which vary by age and gender (Table 1), the population of older adults in the model becomes disproportionately more female in line with real world trends. Upon entry into the model, adults in each household are assigned to a residence and each employed adult is randomly assigned to a workplace. Each adult is assigned properties including depression status, income level, driver's license status, car ownership status, and employment status. The distribution of these variables is based on national prevalence data from the US (see Table 1). Each adult is assigned attitudes towards driving, public transit use, and walking using a random draw from a uniform distribution ranging between 0 and 1.

2.2. Dynamic processes

2.2.1. Aging and Events

At each step, all existing adults age one year. Adults leave the model once they reach 85 years or if they die. At Step 20 (when the group of older adults who entered the ABM at Step 1 reach 85 years), the model reaches an equilibrium state with the total living population stable at roughly 18,500 individuals aged between 65 and 85 years with a pyramid structure.

Events (i.e., death, retirement, and loss of driver's license) occur at each time step based on age- and gender-specific probabilities derived from empirical data sources (see Table 1). For example, the probability that a 75-year-old female in the model will lose her driver's license is based on data for

females of the same age, as informed by data from the U.S. Census Bureau (US Census Bureau, 2017). Similarly, each adult may switch between having or not having depression at each time step with a probability calculated based on their current depression status, age, gender, daily transport, and neighborhood environment (see Subsection 2.2.3 below). Similarly, older adults' transition out of the workforce is informed by data stratified by age and gender (see Table 1).

2.2.2. Transport and feedback

For each time step, we simulate each older adult's transport within a typical week. Empirical studies have reported that the average travel time budget across population samples is approximately 1.1 hours per person per day (Schafer & Victor, 2000; Zahavi & Talvitie, 1980). Compared with the younger adult population, older adults tend to make fewer trips (Collia et al., 2003; Horner et al., 2015). The city in our model is relatively small and our model only captures travel within the city (i.e., all travel outside of the city is ignored by the model and thus should be deducted from the travel time budget). Based on these considerations we set a total travel time budget of 3.5 hours per week for each older adult, and assumed this travel time budget does not change with age.

Adults in the model engage in travel for four purposes: 1) work, 2) basic needs, 3) social activities, and 4) walking for leisure. It is reasonable that a person will prioritize travel for work and basic needs over travel for social activities. Within a typical week, an older adult will travel by the following sequence until the travel time budget is used up: five trips for work (if the person has a job), seven trips for basic needs (one trip per day), and seven trips for social activities. If there is still travel time budget remaining, individuals will alternate travel for basic needs and for social activities until all time budget is used up. Older adults also have the option of walking for leisure around their household but this is not counted in the total travel time budget.

For each trip, an older adult chooses between three travel modes: (1) driving, (2) public transportation, or (3) walking. This choice is made by evaluating the relative utility of each travel mode; where modes with higher utility have a greater likelihood of being selected. The utility of a given travel mode is positively associated with an individual's attitudes toward this mode and negatively associated with the cost of travel (e.g., fuel price, bus fee, parking fee, and travel time cost). Attitude towards walking is updated through a feedback mechanism. The idea is that a positive past experience of travel using a certain travel mode may positively increase the attitude towards this mode, and vice versa. The attitude towards walking is affected by the safety and walkability along the travel path. For simplicity, the attitudes towards public transit and towards driving are assumed constant. See Yang et al.'s ABM for detailed information relating to the formula on travel mode choice and feedback (Yang et al., 2015).

2.2.3. Depression

We operationalized depression as clinically significant depressive symptoms (i.e., a score ≥4 on the Center for Epidemiologic Studies Depression Scale-8) (West, Cole, Goodkind, & He, 2014). Although clinically significantly depressive symptoms are less severe than major depressive disorder, which meets full DSM criteria and is diagnosed through a structured clinical interview, having these symptoms

increases the risk for adverse outcomes among older adults in a similar way that a diagnosis of major depression does (Meeks, Vahia, Lavretsky, Kulkarni, & Jeste, 2011). At each time step, every adult has the opportunity to transition from their current status. The transition probability is a function of two processes. The first is the aging process where the probability of changes are based on age and gender (Table 1). The second process is how daily transport and neighborhood environment influence depression state using the following formula (equation 1).

$$P = w_t \left(\frac{t}{T} - 1 \right) + w_d \left(\frac{d}{D} - 1 \right) + w_e \left(1 - \frac{e}{E} \right) \quad (1)$$

Where P is the probability of transitioning and t, d, e are an older adult's total non-work trips, total walking distance, and EDR in the neighborhood during the past week, respectively, and where T, D, and E are corresponding threshold constants which were assigned based on empirical data. w_t, w_t, and w_t are weights with the sum equaling to one. These weights indicate the magnitude of the influence of total non-work trips (for simplicity, we assume that only non-work trips influence depression as these types of trips occur more routinely among older adults than non-work trips), total walking distance, and EDR on depression status. Here, $w_t = w_t = w_t = 1/3$. If $P>0$, the older adult has a probability P of changing status from being depressed to not depressed. If $P<0$, the older adult has a probability of P to transfer from not being depressed to depressed. If $P=0$, the adult remains in the same status.

2.3. Baseline scenario and model validation

The baseline scenario reflects the segregation patterns by income level present in many US cities where lower-income households are more likely to be located in the center of the city and higher-income households are more likely to be located in the periphery (Berube, Katz, & Lang, 2003). At the same time, evidences show that neighborhood poverty is associated with crime (Graif, Gladfelter, & Matthews, 2014; Hsieh & Pugh, 1993). Poor neighborhoods tends to lack amenities that are beneficial to mental health (Joshi et al., 2017). As Figure 2 shows, the density of non-residential locations decays outwards from the center of the city, such that more non-residential locations are in the core and fewer non-residential locations are in the periphery. At the same time, EDR and safety decay inwards towards the center of the city, such that there is lower EDR and safety in the core and higher EDR and safety in the periphery. We assume no spatial pattern of walkability.

The model was validated by comparing the model results with the general empirical patterns in the US including the variation of depression by gender, age, and income level. As our simulated results show in Figure 3, adults that are female, older, or with lower income level have a higher prevalence of depression than adults who are male, younger, or with higher income level, respectively. This is consistent with US national patterns (Dunlop, Song, Lyons, Manheim, & Chang, 2003; Steffens, Fisher, Langa, Potter, & Plassman, 2009; Thielke, Diehr, & Unützer, 2010; West et al., 2014).

2.4. Scenario analysis

We explored three categories of interventions to decrease depression. The first intervention aimed to promote walking by increasing the walkability and safety of neighborhoods across the whole city. This was implemented in a scenario **W** (for walking). In this scenario, for all zones across the city,

walkability and safety were increased to be the maximum value in the model (i.e., 1). Second, an intervention promoting public transit through decreased bus fares (change from one dollar per trip to be free for older adults) and bus waiting times (decreased from 6 minutes to be 3 minutes per trip) was explored. This was implemented in a scenario **F** (for bus fare). Third, an intervention promoting public transit through the simultaneous addition of bus lines (an increase from 6 lines to 14 lines) and bus stations (the total number of stations were increased from 57 to be 385 and the distance between stations were decreased from 400 meters to be 200 meters) was simulated. This was implemented in a scenario **L** (for bus line). We also explored the combinations of above three interventions.

3. Results

Figure 4 shows the variation of depression prevalence by age, in the context of several interventions. Overall, the depression prevalence increases with age. Compared with the baseline scenario, the depression prevalence in scenarios **W**, **F**, **L**, **W** + **L**, and **W** + **F** decreases mildly, and among them, scenario **F** (i.e., decrease bus fare and bus waiting time) is relatively more effective than others. The most effective scenarios are **F** + **L** and **W** + **F** + **L**.

Figures 4 shows the variation of depression percentage, total trips, total bus trips, and total walking distance, by age and income level, under baseline and **F** + **L** scenarios . In general, under all four scenarios, higher income groups have lower rates of depression, more total trips, fewer bus trips, and smaller walking distances than lower income groups. Older adults have higher depression prevalence and fewer total trips than younger adults. The pattern of total trips and active travel by income is consistent with empirical data (Quinn, Jakicic, Fertman, & Barone Gibbs, 2016) further validating our model. Specifically, **F** + **L** is the most effective scenario in decreasing depression prevalence, particularly among lower income groups. Moreover, the depression prevalence gap among different income groups is much narrower under **F** + **L** than the baseline scenario. Similarly, the total trips are significantly higher under the **F** + **L** scenario compared to baseline, and the increase is again much larger for lower income groups. Additionally, the total walking distance in Scenario **F** + **L** decreases slightly for all income levels relative to the baseline scenario. As shown by Figure 6, scenario **F** (i.e., decrease in bus fare and bus waiting time) is particularly effective in increasing total bus trips for lower income groups 1 and 2 while scenario **L** (i.e., add bus lines and stations) is moderately effective in increasing total bus trips for all income groups. The **F** + **L** scenario displays a synergistic effect in increasing bus trips, as the increase of bus trips when F and L are combined is larger than the sum of the individual effects of scenarios **F** and **L**.

4. Discussion

By representing a plausible dynamic pathway of how the daily transport and neighborhood environment jointly influence depression among older adults, the model allows us to explore the possible impact of various transportation and built environment interventions on depression. As our results show, an intervention that combines a decrease in bus fare and bus waiting time with the addition of bus lines and stations is most effective. Promoting public transit use is a promising strategy by which to increase older adults' daily transport and decrease depression prevalence, particularly among lower income

1 groups which appear more sensitive to public transit-oriented interventions. Our results may have
2 implications for transportation policies and highlight possible unintended benefits of transportation and
3 built environment intervention for older adults' depression risk.

4   It may be counterintuitive that increasing neighborhood walkability and safety (scenario **W**) has
5 almost no effect on depression prevalence. A possible explanation for this finding may be that increases
6 in walkability and safety lead to increases in people's favorable attitude towards walking, which in turn
7 makes them more likely to choose walking over other travel modes. However, for most trips, except very
8 short trips, the trip duration is longest when walking is the chosen travel mode. One implication of this
9 and the fact that the model assumes a fixed daily travel time budget is that an increase in the frequency
10 of daily walking trips results in a faster depletion of the daily travel time budget. This ultimately limits the
11 number of non-work trips that may be taken. Since both the number of non-work trips and the total
12 walking distance directly influence depression, the reduction in the total number of trips may outweigh
13 the beneficial effects of walking.

14   In contrast, using public transit typically takes less time than walking as long as buses arrive
15 frequently. The reduction in bus waiting time, which is achieved by adding bus lines and bus stations,
16 increases the relative advantage of using public transit compared to driving. Scenarios that combine F and
17 L show the greatest reduction in prevalence of depression for the lower income groups. This is because
18 lower income groups are more sensitive to bus fare decreases. Therefore, while scenario **F + L** increases
19 total non-work trips traveled by bus, these trips do not decrease overall walking distances because people
20 still need walk to the bus stop in order to access the service.

21   ABM, as a modelling process, could include a finite number of key elements. Our decisions about
22 which variables to include were guided by our judgement and some potentially important features and
23 associations among features may be neglected. For example, our model did not cover an older adult's
24 physical health status despite the associations between physical health status, the aging process, daily
25 transport, and depression (Yuri & Brenda, 2014). Furthermore, the processes leading to the development
26 of depression are grossly simplified. The values for some parameters (e.g., the total travel time budget)
27 may be arbitrary to some extent. Other features excluded from this model include carpooling,
28 transportation provided by family and friends, the impact of weather on travel decision, the length of
29 time older adults have resided in their neighborhood, ride-sharing technologies like Uber and Lyft, and
30 driverless vehicles. More empirical studies are needed to provide additional rationales for rules and
31 mechanisms, as well as, more precise values for parameters (e.g., travel time budget among older adults).

32   Despite the above limitations, our study can help deepen our understanding of the interrelated
33 processes that link aging, daily transport and depression risk among older adults. We view this simple,
34 abstract model as a tool for preliminary exploration and insight and the basis for developing more
35 sophisticated modeling approaches that can inform how urban policies may impact mental health among
36 older adults. For example, an adapted version of the model could be used to study depression disparities
37 by income level, because household income impacts travel mode choice, the availability of having a car at
38 home, and neighborhood characteristics.

Our preliminary findings highlight the potential importance of providing and improving public transit for older adults. High-quality public transit is a promising strategy because it can increase the number of trips without excessive increase in the time needed to travel and promotes walking. In addition, public transit is crucial for those who do not have a car or are increasingly unable to drive as they age (Choi & DiNitto, 2016). However, recent data shows that only 2.3 % of all trips among US older adults use public transit (Lynott & Figueiredo, 2011). Barriers to public transit use among older adults include concerns about safety; the reliability, comfort, and habitual dependence on driving; the walkability of the neighborhood environment; and lack of public transportation availability (Peck, 2010; Transportation for America, 2011). The reduction of these barriers in order to increase public transit use among older adults will require multiple strategies and investments.

Our study is not intended to be definitive or account for the complete range of factors that influence depression risk among older adults. Rather, the ABM allows us to integrate knowledge from different fields and combine data from various sources. The ABM helps identify critical gaps in knowledge and data by "forcing" investigators to make tacit knowledge explicit and specify the mechanisms generating key "stylized facts" of interest. For example, during the model process, we found that the existing knowledge and data on the inter-relationships between the dynamic processes of aging, depression, and environmental influence are extremely limited. Iterative interactions between ABMs and empirical research - wherein ABM integrate existing knowledge and also prompt the production of new knowledge - should be encouraged.

1   Table 1. Individual and household level parameters and supporting data sources

Parameters	Value range	Prevalence at age 65 and data source	Parameter for change over time (e.g., incidence) and data source [1]
Age	65-85		Mortality rates from National Vital Statistics Reports, 2014 (Kochanek, Murphy, Xu, & Tejada-Vera, 2016)
Gender	Male/female	50% male, and 50% female	No change
Income level	1-5	Evenly distributed from 1 (lowest) to 5 (highest)	No change
Depression (clinically significant depressive symptoms, score of ≥4 on the Center for Epidemiologic Studies Depression Scale-8)	Yes/no	10% of males; 17.5% of females. From Federal Interagency Forum on Aging-Related Statistics, 2012; and Health and Retirement Study, 2008 (West et al., 2014)	Incidence rate and probability of keeping depressed. From Cardiovascular Health Study (Thielke et al., 2010)
Driver's license	Yes/no	95% of males; 89% of females. US Census, 2014 (US Census Bureau, 2017)	Incidence rate of losing driver's license. From 2014 US Census (US Census Bureau, 2017)
Employment status	Yes/no	44% of males and 33% of females. From the Health and Retirement Study (Karp, 2007)	Incidence rate of losing job. From Health and Retirement Study (Karp, 2007)
Car ownership	Yes/no	Prevalence by income quintile (highest to lowest): 26.6%, 6.5%, 2.2%, 1.3%, and 2.0%. From 2009 National Household Travel Survey (NHTS, 2017)	No change

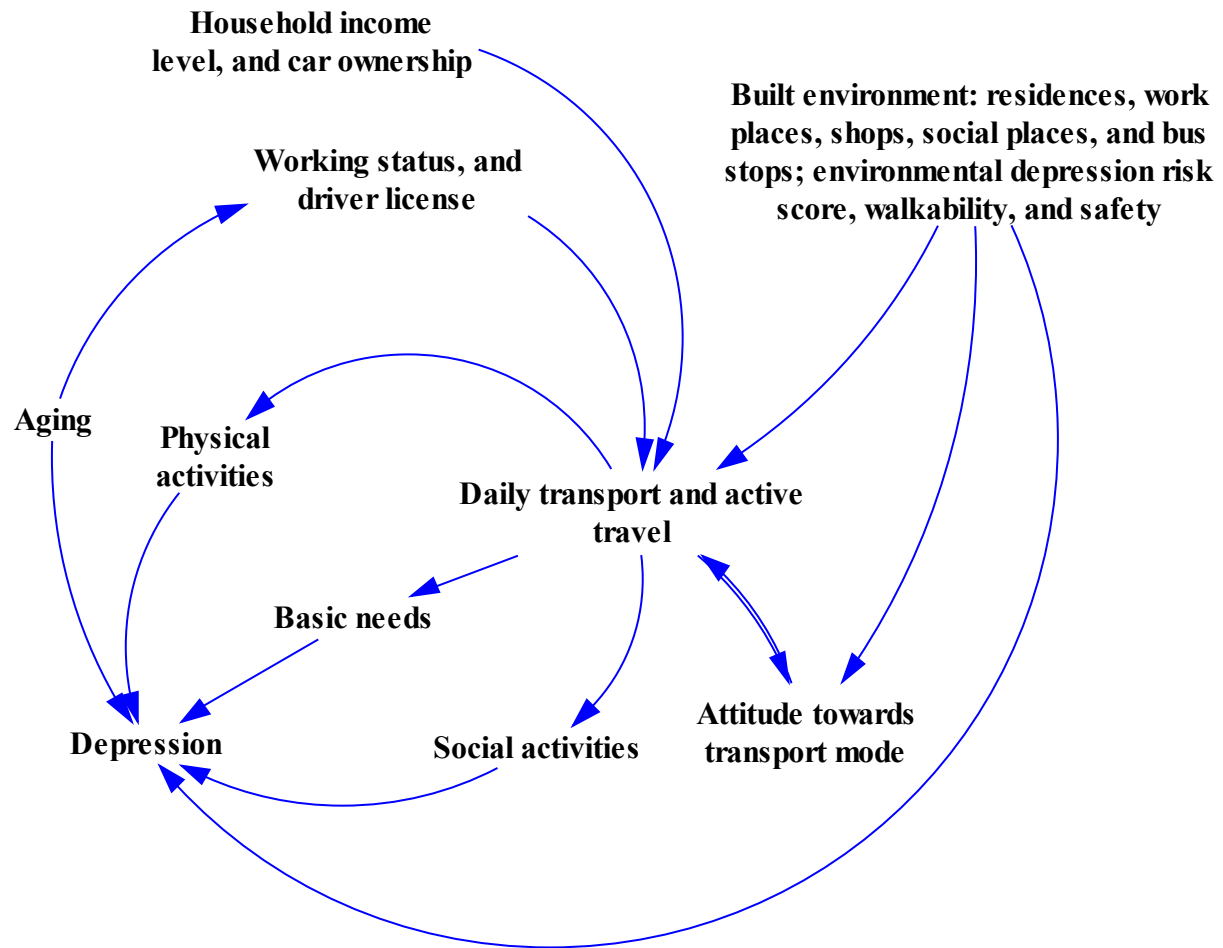[1] All incidence data are age- and gender-specific

2

Household income
level, and car ownership

Working status, and
driver license

Built environment: residences, work
places, shops, social places, and bus
stops; environmental depression risk
score, walkability, and safety

Aging

Physical
activities

Daily transport and active
travel

Basic needs

Depression

Social activities

Attitude towards
transport mode

1
2   Figure 1. Framework for an agent-based model of daily transport and depression among older adults.

3
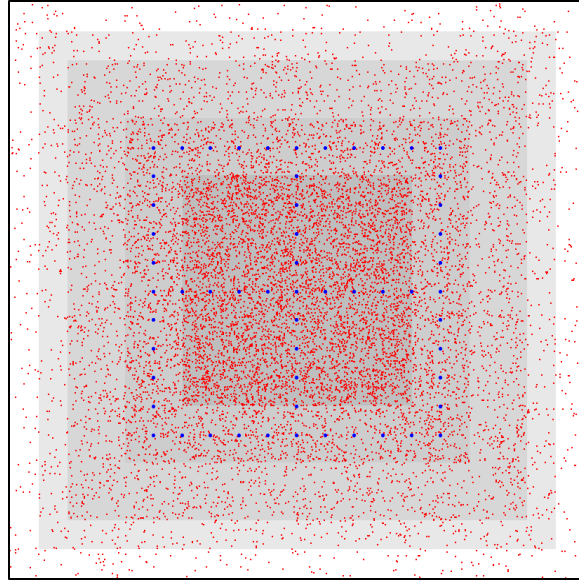
Figure 2. Spatial display of the Baseline scenario. Red dots are locations related to basic needs or social activities, while the blue dots represent transit stations. Residences are not displayed. The city is divided into five concentric zones. Zone 1 is represented by the lightest shade of grey, while zone 5 appears darkest in the center of the square. The income level of residents, environmental depression risk (EDR), and safety decay as one moves inwards from the periphery toward the city center.

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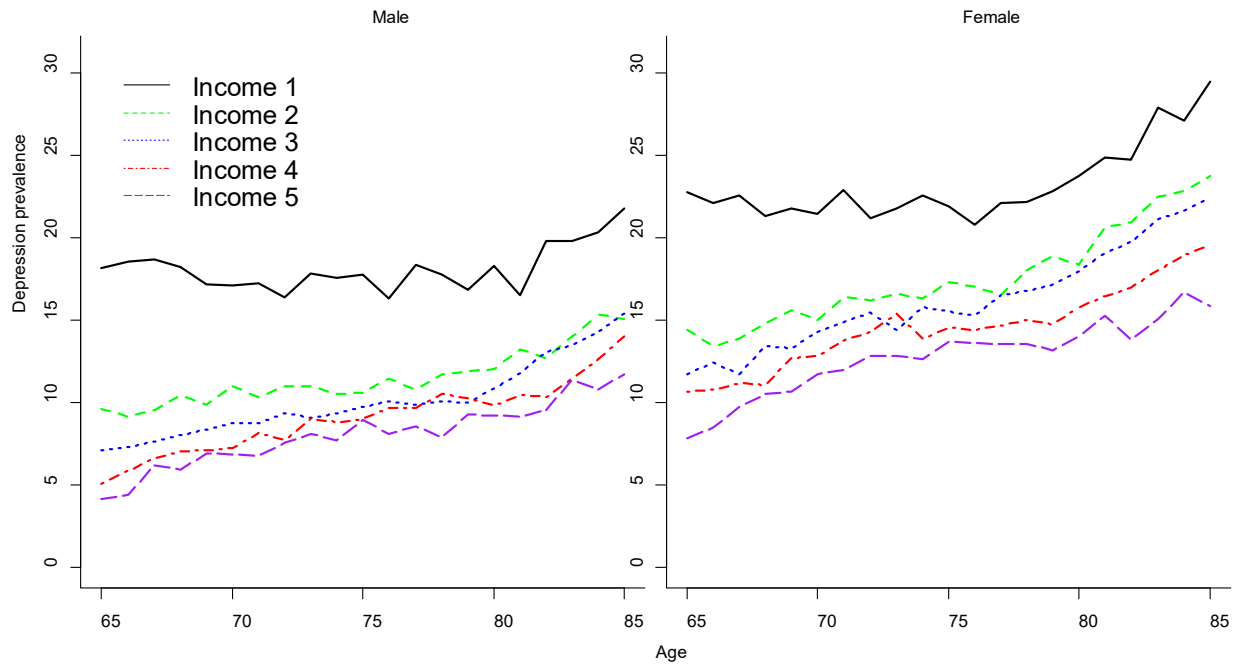
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3   Figure 3. Prevalence of depression by age, gender, and income level in the Baseline scenario.

4

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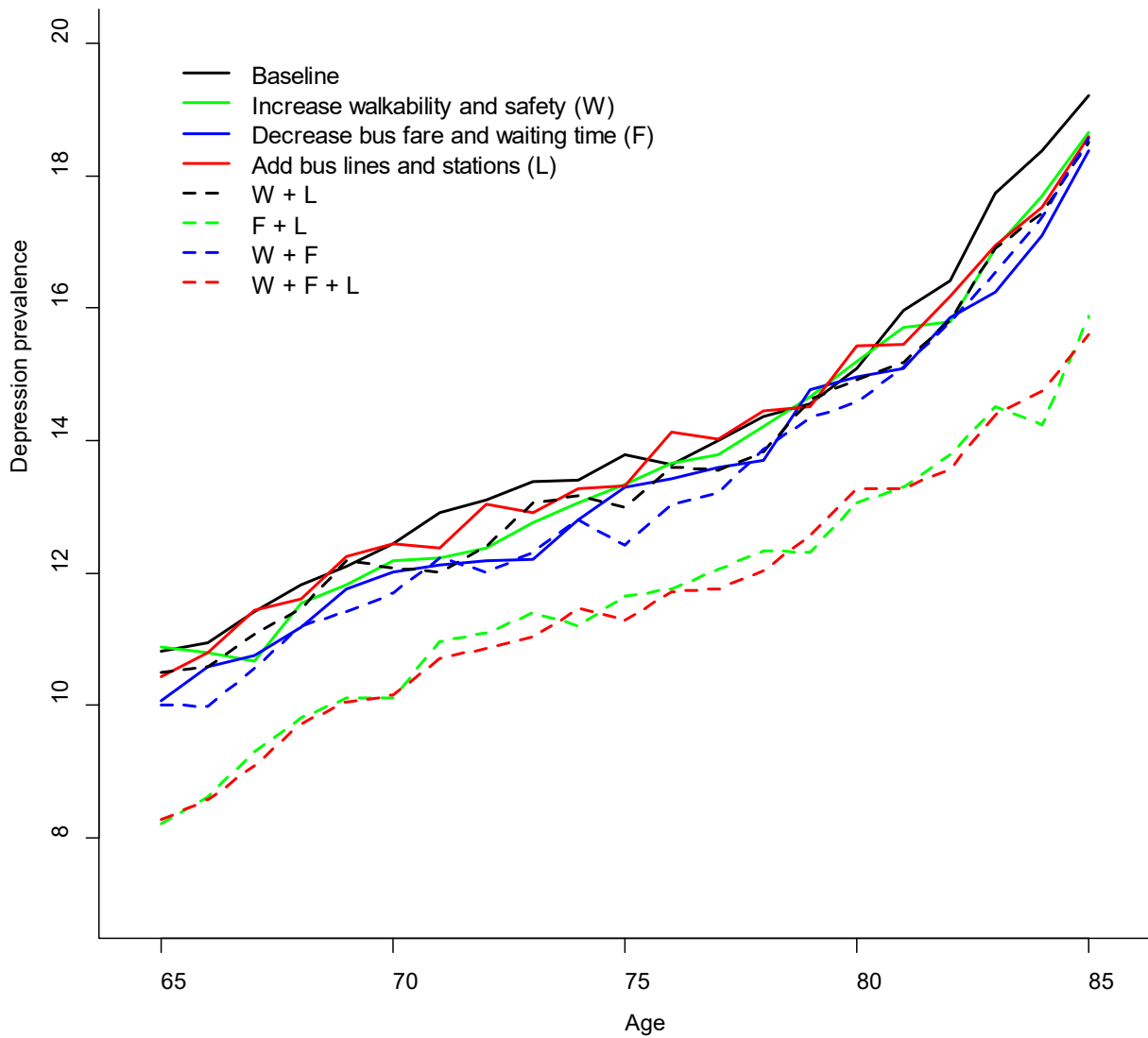
Figure 4. Prevalence of depression by age, in eight different scenarios, including Baseline, Increase
walkability and safety (W), Decrease bus fare and waiting time (F), Add bus lines and stations (L), Increase
walkability and safety + Add bus lines and stations (W+L), Decrease bus fare and waiting time + Add bus
lines and stations (F+L), Increase walkability and safety + Decrease bus fare and waiting time (W+F), and
Increase walkability and safety + Decrease bus fare and waiting time + Add bus lines and stations (W+F+L).
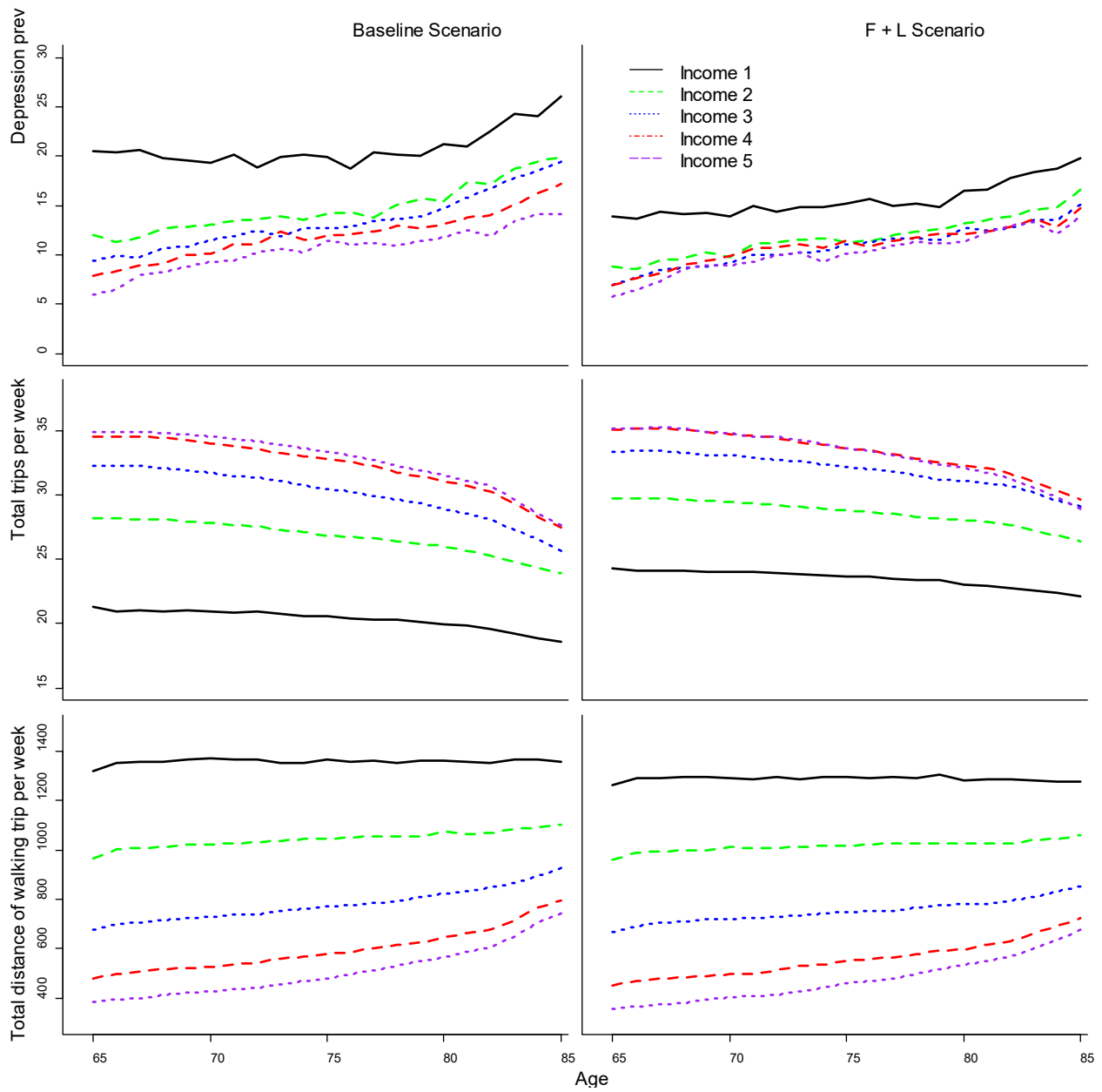
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Figure 5. Prevalence of depression, total trips per week, and total distance of walking trips per week, for the Baseline, and Decrease bus fare and waiting time + Add bus lines and stations (F+L) scenarios.
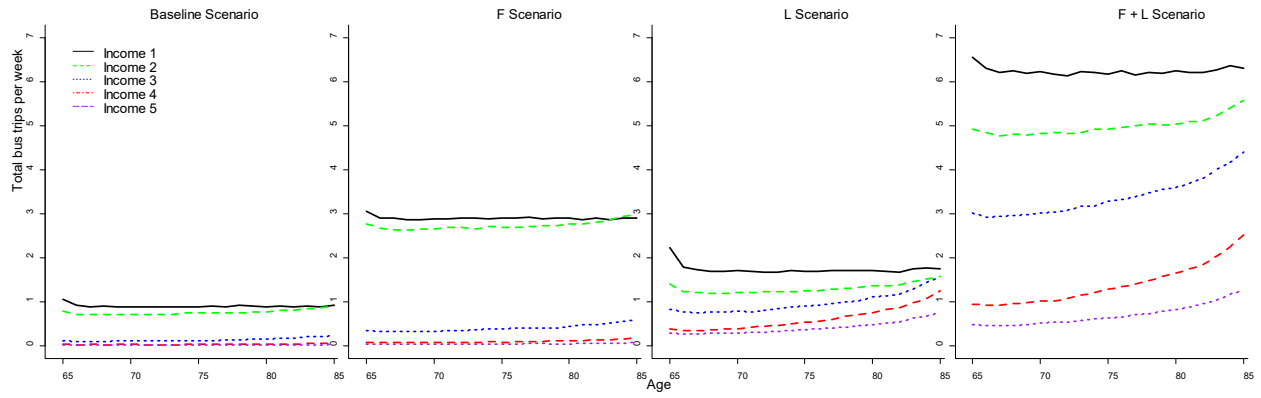
Figure 6. Total bus trips per week, in four scenarios, including Baseline, Decrease bus fare and waiting time (F), Add bus lines and stations (L), and Decrease bus fare and waiting time + Add bus lines and stations (F+L) scenarios.

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