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Public transport availability and healthcare use for Australian adults aged 18–60 years, with and without disabilities

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ABSTRACT

Introduction: Public transport (PT) availability may be more important for people with disabilities (PWD), as typically they have greater healthcare needs and mobility barriers compared with people without disabilities. This paper investigates how PT availability is associated with healthcare use for people aged 18–60 years, with and without disabilities in Australia.
Method: We used unique Australian healthcare use administrative data linked to the 2016 Census, where individuals report whether they have a disability (severe or profound core activity limitation). These data were merged with detailed information on local area PT availability for Australia's 21 largest cities. We estimated regression models to examine the association between PT availability and different types of healthcare use, while controlling for individual characteristics and larger area attributes.
Results: PT availability was positively associated with visits to general practitioners (GP), with a higher magnitude observed for people with disabilities (PWD). While people without disabilities had on average 0.1 more GP visits per year when PT availability was high compared with low, PWD on average visited their GP 0.5 more times per year if they lived in areas with high as opposed to low PT availability. Nervous system prescriptions (which includes antidepressants) were 0.27 per year fewer for PWD living in areas with high compared with low PT availability. Conversely, nervous system scripts were 0.06 higher for people without disability with high compared with low PT availability.
Conclusion: We conclude that PT availability is likely to be a key factor of healthcare use. Increasing PT availability may help overcome some barriers to healthcare use for PWD. Our findings are also consistent with PT increasing access to preventive care, which may reduce the severity or better management of illnesses. PT can play an important role in improving health and decreasing health inequalities between those with and without disabilities.

1. Introduction

In 2018, 17.7% of Australians were living with a disability including 5.7% with a core activity limitation (Australian Bureau of Statistics, 2018). Among those with disability, 60% needed assistance in one activity of daily life, with healthcare the most commonly

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reported activity (Australian Bureau of Statistics, 2018). People with disability (PWD) are more likely to be living with chronic illness and have a higher demand for healthcare than the general population (Australian Institute of Health and Welfare, 2010; Emerson et al., 2011; Mithen et al., 2015). They are also likely to be more vulnerable to ill health than their counterparts without a disability. PWD often do not have the same access to healthcare, education or employment than those without disability and experience higher levels of exclusion from daily activities (World Health Organization and World Bank, 2011).

Disability is not simply a characteristic of a person's body or structure, rather it stems from how any impairments interact with society and the environment, and the urban environment can be particularly important (Clarke et al., 2011). For example, accessible and available public transport (PT) may not only improve healthcare use, but also provide opportunities to access employment, recreation, and to socialise (Giles-Corti et al., 2016). Having a disability is associated with lower odds of taking a trip whether for shopping, for social recreational reasons, running errands or going to work (Henly and Brucker, 2019). Moreover, PT may be more important for PWD compared to the general population because PWD are less likely to have access to private transport (e.g. a private motor vehicle) (Frier et al., 2018), notwithstanding that the nature of one's disability may lead to different barriers in terms of accessing PT (Park and Chowdhury, 2018). When PT availability improves and can be used by PWD, it may decrease social isolation and reduce barriers to visiting destinations, including health services. If this holds true, decreases in social isolation may improve mental health and reduce the need for treatments such as antidepressants. Further, if PT eases access to medical visits, we may observe higher GP and specialist visits, but fewer prescriptions administered on the condition that illnesses are prevented, treated earlier, or better managed as a result. This may be even more acute when individuals do not live close to a GP. In this paper, we examine how the availability of PT is associated with different types of healthcare use in Australia by disability status.

The literature has documented transport as a key barrier for socio-economic participation and accessing healthcare for PWD and people on low income. Edwards et al. (2020) found that transport barriers were a main concern when reviewing challenges to cancer services access for adults with a physical disability. Three studies in their review reported that having access to an improved and/or a reliable transport service, or obtaining a referral to a closer clinic would have positively influenced health seeking behaviours. Maart and Jelsma (2014) sampled 1083 households in a deprived area in Cape Town, South Africa, including 152 PWD. The two main issues reported by PWD regarding access to healthcare services were finances (71%) and transport problems (72%). In contrast, Clarke et al. (2011) found that PT played a minor role compared with heavy traffic, street quality and residential security for PWD's participation in interpersonal interaction, preventive healthcare, and voting in Chicago, US. Syed, Gerber, and Sharp (2013) reviewed 61 studies investigating transport barriers and healthcare access in the USA and found that for those with lower incomes, transport barriers were an important impediment to healthcare access. Given that PWD are, in general, on lower incomes, with a median gross personal income half of those without disability (Australian Bureau of Statistics, 2019a), this may add to their transport barriers. While many studies have documented transport as a key barrier for PWD in accessing healthcare and other activities of daily living, few studies have investigated whether better PT is associated with healthcare use by disability status.

There is a need to better understand whether PT availability is related to healthcare use in PWD and how this compares with its role for the general population. Addressing the complex question of the role of PT in healthcare use inequalities requires an accurate measure of PT availability, examining the proximity to a PT stop as well as the service frequency. But for PWD, availability may not always translate into better access. Bezyak et al. (2019) observed that other barriers to PT quickly impact the ability of PWD to fully experience their community. The PT needs and barriers those with disability face differ by impairment type (Beyzak et al., 2019; Rachele et al., 2020). Beyzak et al. (2019) noted that individuals with blindness or low vision, psychiatric disabilities, chronic health conditions, or multiple disabilities were more severely impacted by barriers to PT than those with other disabilities. For those with intellectual or developmental disabilities, training can be provided to increase their transport navigation skills (Pfeiffer et al., 2020). Thus, while one can plausibly expect higher healthcare use when PT availability is high, it remains unknown whether those with disabilities will benefit from it.

In this paper, by combining administrative healthcare use data with local PT data, we aim to examine whether PT availability (a measure comprising of availability and accessibility) is associated with healthcare use. We investigate this relationship for people aged 18–60 years with and without disability living in Australia's 21 major cities, while controlling for local areas effects and individual characteristics. To shed more light on the role of PT in improving access to primary care, we also examine how the association between PT availability and GP visits varies by distance to their nearest GP. We hypothesize PT to play a more minor role when a GP is available in the local area.

2. Material and methods

2.1. Administrative datasets

The primary data came from the Multi-Agency Data Integration Project (MADIP) Basic Longitudinal Extract (BLE) 2011–2016 Cohorts (Australian Bureau of Statistics, 2019b). This dataset contains information for the 2016 Australian resident population. These data stem from key Australian government administrative datasets including the: Medicare Benefits Schedule (MBS); Pharmaceutical Benefits Scheme (PBS); and Australian Bureau of Statistics (ABS) 2016 Census of Population and Housing. MADIP contains information on annual medical visits (GP and Specialist), annual prescriptions filled (including scripts for the nervous system which comprise antidepressants), key demographic information and the location, given at the Statistical Area Level 1,[1] for all 2016 Australian residents (see Saxby et al., 2020 for further details). Both the annual number of scripts and medical visits are top coded at 30 per year to maintain confidentiality for unique high use individuals.[2] We analyse healthcare use (MBS and PBS) in 2016 as the identification of PWD comes from the 2016 census and this aligns with our PT data described below.

We define a person as living with a disability (hereafter, PWD) if they were reported as having a profound or severe disability in the Census 2016. Having a profound or severe disability was defined in the census as needing help or assistance in at least one core activity such as self-care, mobility and communication, because of a disability, long-term health condition (lasting six months or more) or old age. This is a more restrictive measure compared with other disability definitions, which often include a wider population. Therefore, some people with less restrictive disabilities are likely to be included in our population without disabilities. Our analysis focused on people aged 18–60 years old who needed assistance as a result of their disability or long-term health condition, rather than their age.

2.2. Public transport and GP locations

Our primary data were linked to local area PT availability (number and type of PT stops) and street network distance to the nearest GP practice. These measures were developed by the Healthy Liveable Cities Group, RMIT University. There are advantages of using accurate local area measures of PT availability as opposed to self-reported measures. Delbosc and Currie (2011) find suggestive evidence that self-reported transport disadvantage is unrelated to realised mobility and highlights the need to move away from self-reported measures to define transport disadvantage. Both PT and GP measures were generated and applied at the Statistical Area Level 1 (SA1) administrative geography for the 21 major cities across Australia. The PT and GP measures were computed for every residential parcel lot located within Australia's 21 major cities. For each SA1, the PT measure calculated the percentage of dwellings located within 400 m street network of a PT stop with a frequent weekday service (being at least once every 30 min between 7am and 7pm). PT modes included buses, trams, trains, and ferries. We defined a SA1 as having 'high' PT availability if at least 80% of the population achieved this metric.[3] For each SA1, the GP measure was calculated using the average street network distance to the closest GP based on the National Health Services Directory, 2018.

3. Analytic approach

We are interested in the role of PT availability for PWD and how this compares with the role of PT availability for those without disabilities. Thus, we first describe the characteristics of our four key groups of interest: 1. PWD with high PT availability; 2. PWD with low PT availability; 3. People without disabilities with high PT availability; and 4. People without disabilities with low PT availability.

In order to estimate how the association between PT and healthcare use (GP visits, specialist visits, total medical use, nervous system prescriptions, cardiovascular prescriptions, all prescriptions[4]) varies for people with and without disability we estimate a regression which includes an indicator for whether an individual lived in an area with high PT availability, another indicator for having disability and the interaction of the two. This allows us to not only estimate the association between healthcare use and PT for those without a disability and those with a disability but also to understand whether there were significant differences between these two associations. Our regressions also controlled for a wide range of individual and household characteristics (age, gender, born in Australia, Indigenous status and the presence of another adult in the household). However, areas with high and low PT availability may also differ in significant ways. The population in a particular area may be more willing to invest in PT or rely on PT. They can also have different political views that would make them more likely to invest in inclusive forms of PT that could be more accessible to PWD. Differences such as these can correlate with preferences for health and therefore healthcare use. To control for such differences, our regressions also control for the wider SA2[5] in which the individual lives.

For each healthcare use Y of person *i*, in location (SA1) *p*, included in the larger location (SA2) *m*, we estimated the following equation:

$$Y_{ipm} = \alpha_0 + \alpha_1 X_i + \alpha_2 PT_p + \alpha_3 PWD_i + \alpha_4 PT_p * PWD_i + v_m + u_{ipm} \quad (1)$$

Where PT is an indicator defined at the SA1 level which is equal to one if at least 80% of the population lived close to a high frequency PT service[6] and zero otherwise. The PWD variable is an indicator which is equal to one if the individual reported a core limitation in managing daily activities and zero otherwise. The vector X_i comprised information about individuals which may be associated with

[1] SA1s are the smallest routine geographic areas available from the Australian Bureau of Statistics and have a population between 200 and 800 people with an average of approximately 400 people (Australian Bureau of Statistics, 2016).

[2] The appendix reports the numbers and proportions of individuals with 30 uses for each of our key healthcare use variables. PWD are more affected by the top coding and the two variables for totals (total MBS/services used and total PBS/scripts used) are the most affected by the top coding.

[3] Figure S1 in the appendix shows the distribution of the PT variable across statistical area level 1 (SA1).

[4] The total number of scripts includes every types of scripts such as cardiovascular prescriptions and nervous system prescriptions but also all other types of prescriptions.

[5] An SA2 represents a community that interacts together socially and economically. SA2s have a population between 3000 and 25,000 individuals with an average population of approximately 10,000 people. Within cities, SA2s represent gazetted suburbs (Australian Bureau of Statistics, 2016).

[6] This measure is consistent with usual cut offs used by policy makers as can be seen in the report by Arundel et al. (2017).

both healthcare use and their need to access public transport, such as age, sex, whether the person was born in Australia, their Indigenous status, and the presence of another adult household member. v_m represents an area level fixed effect for all individuals living in that area, in our case the effects for each SA2. The regression is then often referred to a SA2 fixed effect estimation or SA2 within effect estimation. u_{ipm} is an error term and is assumed to be clustered at the location level m when estimating the standard errors.[7]

α_2 refers to the differences in healthcare use Y associated with living in areas with high versus low PT availability for people without disability. α_3 refers to the differences in healthcare use Y associated with having a disability compared with individuals without disability for those living in areas with low PT availability. The term $\alpha_2 + \alpha_4$ refers to the differences in healthcare use Y associated with living in areas with high versus low PT availability for PWD. The coefficient of interest is α_4, which indicates the extent that the absolute difference in healthcare use for those with high compared to low PT availability for PWD was greater or smaller than the absolute difference related to PT availability for their counterparts without disabilities.

Given that part of the reason why PT may be associated with healthcare use is that it may enable greater healthcare access, we also investigated how the association between PT and the number of GP visits differed if individuals in their SA1 were already living close to a GP. If the role of PT availability is that it enables greater access to healthcare providers, then we would expect PT availability to have a much smaller association for those already living close to a GP and to be higher (matter more) for those who live further away from a GP practice. PT may still matter to people living close to a GP, as PT availability can ease access to a *preferred* GP (or ease access to specialist care that may naturally flow on from a GP visit). However, our *a priori* was that the effect of PT availability would be smaller for those living close to a GP. To test this assumption, we combined the administrative dataset to the location dataset which contained information on average street network distance to the nearest GP as computed in 2017. By splitting our sample by distance to nearest GP and analysing how GP visits varied, we can understand whether PT availability has a weaker association to healthcare use for those already living close to GP and therefore whether PT availability facilitated access. We partitioned our sample into four groups, and given our definition of high PT, we used GP availability within 400 m as our first group. Individuals in this subgroup were on average as close to the PT service as they were to their nearest GP. We then subsequently divided the rest of the population into those areas where on average individuals are living more than 400 m away from the nearest GP but less than 1 km (1 km is the median), more than 1 km but less than 2 km, and finally those living at least 2 km away.

4. Results

We first describe our sample before outlining our regression results.

4.1. Sample characteristics and healthcare use

Table 1 shows the characteristics and healthcare use by PT availability for PWD and those without disability. It provides the mean and standard deviations for 18–60 year old Australian residents in 2016 and for each subgroup defined by whether they have a disability, and whether they live in areas with high or low PT availability. As outlined in the table, PWD are on average older and much more likely to identify as Indigenous than their counterparts without disability. Further, those living in areas with low PT availability are more likely to be born in Australia and more likely to be living with another adult household member. PWD represent 2.7% of our sample.[8] Overall, 19% of PWD live in areas with high PT availability, compared with 23% for people without disabilities. In comparison to people without disabilities, PWD visit GPs or specialists more and have higher use of medical services and prescriptions in general.[9] PWD living in high PT availability areas, have higher use of medical services and medical visits while receiving less scripts compared with PWD living in low PT availability areas.

4.2. PT availability and healthcare use

Table 2 shows the estimated regression for each healthcare type corresponding to equation (E1) where we attempt to control for other factors when examining the association between PT availability and healthcare use. The reference group here is people without disability living in areas with low PT availability. The coefficient on the variable for high PT availability (PT) indicates that for those without disability, access to such transport is associated with a small but significantly higher number of GP visits (0.09 visits more per year) and slightly fewer specialist visits (0.04 specialist visit less per year). This group also uses on average 0.03 more total medical services and has 0.1 more scripts filled per year. It should be noted that our sample size of 8,663,327 individuals is very large, and therefore even very small differences achieve statistical significance. Thus it should be noted that the association of healthcare with PT availability for those without disabilities is small, especially when compared with changes experienced for PWD as described below.

[7] In the main regressions the location p is the SA2 where the individual resides. The supplementary material provides additional specifications where location p is set at the SA1 and therefore p = m in equation (E1). Given that PT is only available at the SA1 level, solely the difference in the association between living in high versus low PT availability areas and healthcare use for those with and without disabilities can be identified.

[8] The last row reports the number in each of column. The percentage of individuals with disability is therefore: (198,063 + 36,972)/8,663,327 = 2.7%.

[9] Medical services combine all MBS outcomes, that is GP and specialist visits but also blood tests, radiology and all healthcare use except for hospital use and scripts.

Table 1
Characteristics and healthcare use by disability status and PT availability for 18–60 year olds.

	People without disabilities		People with disabilities		Total
	Low PT availability	High PT availability	Low PT availability	High PT availability	population
Panel A: Mean (standard deviation) for demographic (control) variables					
Age (years)	38.87	37.71	43.02	44.10	38.77
	(12.06)	(11.54)	(12.68)	(12.17)	(12.01)
Female	52%	51%	51%	51%	51%
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Born in Australia	67%	59%	73%	65%	66%
	(0.47)	(0.49)	(0.44)	(0.48)	(0.48)
Indigenous status	1.8%	1.0%	5%	3.4%	1.7%
	(0.13)	(0.10)	(0.21)	(0.18)	(0.13)
Other adult in household (18–65 years)	76%	66%	64%	53%	74%
	(0.43)	(0.48)	(0.48)	(0.50)	(0.44)
Panel B: Healthcare use per year (MBS and PBS)					
GP visits	4.75	4.49	9.58	9.96	4.83
	(4.80)	(4.68)	(8.07)	(8.25)	(4.96)
Specialist visits	0.89	0.97	2.78	3.22	0.96
	(2.38)	(2.59)	(5.24)	(5.761)	(2.57)
Total Medical services	12.03	11.69	19.72	20.46	12.18
	(10.05)	(10.05)	(10.66)	(10.46)	(10.15)
Nervous System Prescriptions	0.74	0.59	9.94	9.53	0.96
	(3.46)	(3.13)	(11.50)	(11.36)	(4.13)
Cardiovascular Prescriptions	0.43	0.33	4.14	4.07	0.51
	(2.64)	(2.30)	(8.13)	(8.04)	(2.93)
Prescriptions, all types	2.17	1.80	16.37	16.21	2.48
	(5.83)	(5.29)	(12.45)	(12.40)	(6.44)
Observations, Number	6,821,710	1,606,582	198,063	36,972	8,663,327
%	78.7%	18.5%	2.3%	0.4%	100%

Key: GP = General Practitioner; MBS = Medicare Benefits Schedule; PBS=Pharmaceutical Benefits Scheme; PT = public transport; PWD = people with disabilities.
All the variables in Panel B are censored at 30. Therefore, the means reported in this panel should be interpreted as lower bounds for the true means.

Table 2
PT availability as a predictor of healthcare use.

	MBS items			PBS items (Number of Scripts)		
	GP Visits	Specialists Visits	Total Medical Services	Nervous System	Cardio-vascular	All types of scripts
	(1)	(2)	(3)	(4)	(5)	(6)
PWD	4.357***	1.785***	6.789***	8.782***	3.302***	13.117***
	(0.027)	(0.021)	(0.030)	(0.055)	(0.027)	(0.040)
PT	0.093***	−0.040***	0.034**	0.057***	0.036***	0.098***
	(0.010)	(0.004)	(0.015)	(0.007)	(0.005)	(0.014)
PTxPWD	0.392***	0.309***	0.595***	−0.325***	−0.094*	−0.072
	(0.057)	(0.042)	(0.068)	(0.095)	(0.056)	(0.084)
Association with PT	0.485***	0.269***	0.629***	−0.267***	−0.058	0.026
for PWD ($\alpha_2 + \alpha_4$)	(0.058)	(0.041)	(0.067)	(0.096)	(0.056)	(0.086)
Observations	8,663,327	8,663,327	8,663,327	8,663,327	8,663,327	8,663,327

Key: GP = General Practitioner; MBS = Medicare Benefits Schedule; PBS=Pharmaceutical Benefits Scheme; PT = public transport; PWD = people with disabilities.
*p < .1, **p < .05, ***p < .01; standard errors in parentheses clustered at the level of the fixed effect (SA2). Each regression controls for SA2 characteristics (with the use of fixed effects) and includes gender, age and age squared, an indicator variable for: being born in Australia, Indigenous status, and presence of another adult in the household. PWD is an indicator variable equal to 1 if the individual has a core disability. PT is an indicator variable equal to 1 if at least 80% of individuals in their statistical area 1 live within 400 m of a PT stop. PTxPWD is the interaction of the two variables. $\alpha_2 + \alpha_4$ corresponds to the effect of PT on the outcome for PWD.

For PWD, we saw they were higher users of medical services, and had more medical visits and prescriptions than those without disability (Table 1). The coefficient on PWD in Table 2 shows that even after controlling for individual characteristics (in particular age) and the SA2 in which they live, the previous observations still hold true. For example, PWD have 4.4 more GP visits and use 8.8 more scripts for nervous system disorders per year. Similar to their counterparts with no disability, having high PT availability led to higher use of medical services. PWD's GP visits increase by 0.49 (0.392 + 0.093) and specialist visits by 0.27 per year. The absolute difference for those with high compared to low PT availability for PWD is greater than the absolute difference related to PT availability

Table 3
PT availability as a predictor of GP visits, by distance to nearest GP.

	(1)	(2)	(3)	(4)
	0–400 m	400-1 km	1 km–2km	2 km+
PWD	4.731***	4.429***	4.228***	4.131***
	(0.086)	(0.039)	(0.035)	(0.060)
PT	0.037	0.056***	0.107***	0.202***
	(0.023)	(0.013)	(0.018)	(0.077)
PTxPWD	0.234**	0.250***	0.178	−0.664
	(0.117)	(0.079)	(0.118)	(0.447)
Association with PT	0.271**	0.306***	0.286**	−0.463
for PWD (α_2+ α_4)	(0.119)	(0.080)	(0.119)	(0.460)
Observations	1,070,302	3,759,154	2,879,498	954,373

Key: GP = General Practitioner; PT = public transport; PWD = people with disabilities.
*p < .1, **p < .05, ***p < .01; standard errors in parentheses clustered at the level of the fixed effect (SA2). Each column corresponds to a different regression run on the subsample of individuals living within a certain distance of the nearest general practitioner (GP) as indicated by the column headings. Each regression controls for SA2 characteristics (with the use of fixed effects) and includes gender, age and age squared, an indicator variable for: being born in Australia, Indigenous status, and presence of another adult in the household. PWD is an indicator variable equal to 1 if the individual has a core disability. PT is an indicator variable equal to 1 if at least 80% of individuals in their statistical area 1 live within 400 m of a PT stop. PTxPWD is the interaction of the two variables. α_2+ α_4 corresponds to the effect of PT on the outcome for PWD.

for their counterparts without disabilities, by 0.39 for GP visits and 0.31 for specialist visits. Of note, the association of PT availability on the number of scripts is negative for PWD: living in an area with high PT availability is associated with fewer scripts required for the nervous system by 0.27 (−0.325 + 0.057) and 0.06 fewer cardiovascular scripts. However, there is no significant difference in the total number of scripts related to high PT availability between PWD and people with no disability.

The results for subgroups based on proximity to the nearest GP are shown in Table 3. For people without disability who live within 400 m of the nearest GP, having high PT availability makes a very small and statistically insignificant difference. For those without a disability who live further and further away from a GP, PT availability becomes a more important positive predictor of additional GP visits. Focussing on PWD, PT availability matters, even for those living within 400 m of a GP. This association is not as large as for PWD living between 400 m and 1 km of their nearest GP (0.037 + 0.234 = 0.271 vs 0.056 + 0.250 = 0.306). For PWD living 1–2 km away from a GP, having a high PT availability is associated with 0.29 additional GP visits, when compared with PWD with low PT availability (0.107 + 0.178). However, for PWD living more than 2 km away from a GP, there is no significant association with PT availability and the interaction term is imprecisely estimated with standard errors about five times larger compared with the other categories. It is noteworthy that compared to those without disabilities, PWD are less likely to see their GP if they live further away from a GP, regardless of PT availability.

5. Discussion and conclusion

Neighbourhood aspects have the potential to influence inequities related to disability. While this is typically understudied, it is important to understand its role so that attention can be paid to where PWD are located, and ensure they are supported by neighbourhood resources. Progressing this aim, this study has combined population-wide administrative data on healthcare use with unique, high quality data capturing distance to nearest GP and the availability of PT to examine the association between PT availability and healthcare use for those with and without disabilities.

Our results have shown that for PWD, living in areas with PT availability was associated with more GP and specialist visits but fewer nervous system scripts (which includes antidepressants). This is compared to those without disability, where living in areas with high versus low PT availability was associated with slightly more GP visits and nervous system scripts but slightly fewer specialist visits. For PWD, greater access provided by PT to a GP may have also increased referrals to specialists, thereby also increasing specialist visits compared with people without disabilities where greater and earlier GP access may have in some cases prevented the need to see a specialist. PWD with high PT availability potentially receive fewer scripts because they have their conditions better managed through their GP and specialists. That is, we expect the lower number of scripts to reflect better treatment of conditions. PT could also have a direct positive effect on mental health due to physical activity benefits gained through accessing PT (Badland et al., 2017) or PT availability increasing their independence and ability to visit relatives and friends and participate in other activities of daily living.

Given the definition of 'disability' used in this study as a severe or profound core limitation, it is noteworthy that we find benefits of PT availability on this PWD subpopulation as *a priori* one may expect they are the least likely to benefit from PT. In Australia in 2018, almost half of those with a profound limitation could not use PT at all, however, less than half of those who could use PT actually used PT and for this group as a whole 87% needed assistance with mobility (Australia Bureau of Statistics, 2019a).

In this paper, we build on previous studies to inform on how PT availability, measured by distance to and service frequency, is associated with healthcare use in particular for PWD. There are several strengths of this paper. First, we use nationally representative data on all Australians living in urban centres with and without disability. Second, we use an innovative measure of PT availability which combined two important dimensions namely distance and frequency, constructed using accurate data aggregated at the smallest level of geographical information available from the Australian Bureau of Statistics. Third, we are able to control for a wide set of potentially confounding factors by using larger area fixed effects thus comparing neighbouring local areas with different level of PT availability. Fourth, we exploit an additional dataset on distance to the nearest GP to understand how the association we capture varies depending on the proximity of primary healthcare services. Fifth, we use administrative healthcare data rather than self-reported use which is likely to contain errors. Finally, the literature has not looked at different types of healthcare use and our data comprises information on visits to both GPs and specialists and number of pharmaceuticals scripts administered which can help hypothesize reasons for the association between PT availability and healthcare use of PWD.

There are a number of limitations worth considering when interpreting these results for policy in practice. Area-based measures, even at a very small level such as the SA1, may be related to individual characteristics where certain individuals select to live in SA1s close to PT, also known as neighbourhood self-selection. Thus, at least part of the associations we find may be related to selection effects, and selection based on PT may be more important for those with a disability than those without a disability, however, our results have controlled for characteristics of the larger SA2 by including fixed effects. Additional results (see supplementary material table S2) show that even when we control for the area characteristics of the SA1, PWD are still disproportionately benefiting from PT. Despite the accuracy of our neighbourhood measures at the smallest available geographical unit, there are still measurement errors. Our measure of high PT availability may more accurately describe high availability for some people in the SA1 than for others. Similarly, some individuals may live closer or further to the nearest GP than indicated by the average distance in the SA1. Another limitation is that disability is self-reported in the Census. When comparing our study with other research using a wider definition of disability, it should be noted that our results apply to a subcategory of PWD, namely those with a severe or profound limitation and our comparison group also includes those with less limiting disabilities. It should also be noted that in this paper we focus our attention on PT availability but for PWD, PT accessibility is of critical importance and having PT available and accessible is likely to have an even stronger association with healthcare use. Unfortunately, data on the accessibility of PT is not currently available.

Based on the findings of this study, it is recommended that PT policies should consider including specific recommendations that, in local areas where there are a significant population of people with a disability, a minimum public transport requirement should be that there is a public transport stop or station on average within 400 m of residences with services at least every 30 min s between 7am and 7pm. This may be particularly relevant in urban growth areas and city fringes where PT availability to access healthcare is known to be poor (Madill et al., 2018). Improving access to PT for people with disabilities is likely to improve healthcare use which is likely to have flow on effects for the health of PWD but further research is needed to confirm this. It is crucial to pay attention to where PWD live to ensure that they are supported by appropriate neighbourhood resources, such as PT availability.

Credit authorship contribution statement

Samia Badji: Conceptualization, Writing - original draft, Writing - review & editing, Formal analysis, Investigation, Methodology, Project administration, Visualization, Software. **Hannah Badland:** Conceptualization, Writing - review & editing, Funding acquisition, Methodology, Software. **Jerome N. Rachele:** Conceptualization, Writing - review & editing, Methodology. **Dennis Petrie:** Conceptualization, Writing - review & editing, Funding acquisition, Methodology, Project administration, Supervision.

Declaration of competing interest

The authors have no financial conflicts of interest to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jth.2020.101001.

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Ethics approval

The study was approved by the Monash University Human Research Ethics Committee (Project 16,739).

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