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*Original Paper*

# A Comparison of Women's Travel to Mammography Services and Average Week Day Trip Length

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***Abstract***

*Long travel distances/times to a mammography service may act as a barrier that hinders women from seeking screening mammography on a recommended schedule. Average weekday trip length data from the New South Wales Travel Survey was compared with the average distance women travelled to a mammography service, the difference was tested using the Wilcoxon Signed Rank Test. The distance travelled to mammography services was statistically greater than the average week day trip length from the New South Wales Travel Survey (4.3 km, 95% CI 3.3 to 5.9 kms, p,0.001). This study has identified that within New South Wales there is a significant difference between average week day trip length travel and client travel to mammography services. Therefore, highlighting that women are undertaking a greater than normal travel burden to access mammography services. The comparison of normal weekday travel and travel to mammography services has enabled the burden of travel to mammography services to be identified. Reducing the burden of travel to mammography services is pivotal to increasing the utilization of mammography services and reducing the inequalities in health comes.*

***Keywords***

*Accessibility, Travel time, Equity, Health Service, Mammography, Breast Screen*

## 1. Introduction

In Australia, population-based breast cancer screening is available through BreastScreen Australia, which targets women aged 50-74 for 2 yearly free screening mammograms; women aged 40-49 and 75 and over are also eligible to attend, but are not actively targeted (AIHW, 2018). In Australia, the BreastScreen Australia program detects approximately 45 per cent of all new invasive breast cancers (AIHW, 2015). Participation in breast cancer screening is associated with more conservative breast surgery and reduced breast cancer mortality risk (Nickson et al., 2012; Morrell et al., 2012; and Roder et al., 2017). Australian breast cancer survival rates are amongst the best in the world, with 83 per cent of women still alive 10 years after diagnosis; increased survival is attributed to earlier diagnosis through screening (and in particular the BreastScreen Australia program) and improvements in treatments (Breast Cancer Network Australia and National Breast Cancer Foundation, 2016).

Participation rates in the program are low, however, with a national take-up rate of only 55 per cent of eligible women (Breast Cancer Network Australia and National Breast Cancer Foundation, 2016). Disparities in use may be due to a number of potential barriers in accessing mammography services, including poor geographic access to services (Khan-Gates et al., 2015). Maheswaran et al. (2006) recognised socioeconomic deprivation and geographical access influence the uptake of breast cancer screening, with lower uptake in more deprived areas and in areas further away from screening locations. Delayed or lack of participation in screening leads to cancers being detected at advanced stages where treatment options are limited, and their survival outcomes are poorer (Breast Cancer Network Australia and National Breast Cancer Foundation, 2016). This disparity causes inequality among Australians who all have the right to accessible healthcare (Breast Cancer Network Australia and National Breast Cancer Foundation, 2016).

Travel time to health care services has been shown to influence both access and utilization (Onega et al., 2011). Khan-Gates et al. (2015) identified that long travel distance/times to a mammography facility may act as a barrier that hinders women from seeking screening mammography on a recommended schedule. Longer times between screenings owing to this barrier may result in a later stage at diagnosis (Khan-Gates et al., 2015). For women with limited geographic access to services, travel time may be an important factor in the type of services received in some phases of care along the cancer control continuum (Onega et al., 2011). The efficiency and the benefits from centralizing screening for breast cancer must therefore be weighed against the risk of a lower participation rate because of a longer distance to the screening sites for some women (Jensen et al., 2013). Therefore, how women factor travel time into their decisions or their capacity to obtain services is likely related to how often they need to travel to the service (Onega et al., 2011).

Understanding the distance that clients travel to mammography services is essential for determining the

catchment zones of mammography services. Variations in house hold travel can be clearly seen in the data from the New South Wales 2014/2015 Household Travel Survey (2014) where the estimated average week day travel in 2014/2015 ranged from 4.3 kms to 18.7 kms (Table 1). Investigating the difference between average weekly day travel and client travel to mammography services will highlight where clients are undertaking further than normal travel to access services and therefore carrying a greater travel burden.

**Table 1. The 2014/2015 Estimated Average Weekday Kilometres Travelled within New South Wales**

| Local Government Area Code (2011) | Local Government Area | Avg Trip Length (kms) NSW Travel Survey |
|---|---|---|
| 10150 | Ashfield | 5.7 |
| 16350 | Auburn | 7.8 |
| 10350 | Bankstown | 7.8 |
| 10750 | Blacktown | 10 |
| 10900 | Blue Mountains | 14.3 |
| 11100 | Botany Bay | 5.5 |
| 11300 | Burwood | 7 |
| 11450 | Camden | 13.2 |
| 11500 | Campbelltown | 11.3 |
| 11520 | Canada Bay | 6.5 |
| 11550 | Canterbury | 6.7 |
| 12850 | Fairfield | 8.4 |
| 13100 | Gosford | 11.9 |
| 13800 | Hawkesbury | 15.2 |
| 13950 | Holroyd | 7.5 |
| 14000 | Hornsby | 9.3 |
| 14100 | Hunters Hill | 8 |
| 14150 | Hurstville | 7.1 |
| 14400 | Kiama | 15.8 |
| 14450 | Kogarah | 7.2 |
| 14500 | Ku-ring-gai | 7.4 |
| 14700 | Lane Cove | 7.2 |
| 14800 | Leichhardt | 4.4 |
| 14900 | Liverpool | 10.9 |
| 15150 | Manly | 6 |
| 15200 | Marrickville | 5.8 |

| | | |
|---|---|---|
| 15350 | Mosman | 5.5 |
| 15950 | North Sydney | 5.8 |
| 16250 | Parramatta | 8.2 |
| 16370 | Pittwater | 8.3 |
| 16550 | Randwick | 5.6 |
| 16650 | Rockdale | 7.9 |
| 16700 | Ryde | 8.1 |
| 16900 | Shellharbour | 10.6 |
| 16950 | Shoalhaven | 9.5 |
| 17100 | Strathfield | 6.8 |
| 17150 | Sutherland Shire | 9.9 |
| 17200 | Sydney | 4.3 |
| 17420 | The Hills Shire | 10.2 |
| 18000 | Warringah | 7 |
| 18050 | Waverley | 4.6 |
| 18250 | Willoughby | 5.8 |
| 18350 | Wingecarribee | 15.4 |
| 18400 | Wollondilly | 18.7 |
| 18450 | Wollongong | 10.3 |
| 18500 | Woolahra | 4.8 |
| 18550 | Wyong | 13.7 |

*Source*: 2014/2015 Household Travel Survey.

**2. Method**

Mammography service client data for 2011-2013 was obtained from the New South Wales Cancer Research Institute. Client records with a geocoded residential address were selected and records with no or zero longitudes and latitude information were removed. Duplicate records based on longitude and latitude coordinates were also removed. Individual client data were linked to mammography service information (mammography service address longitude and latitude based on client IDS). ArcGIS 10.5 was used to locate the client's residence upon the national road network. The shortest distance via the road network between the client's residence and the mammography service they attended was calculated using Network Analyst, ArcGIS.

Average weekday kilometres travelled data from the New South Wales Travel Survey was obtained from the New South Wales Government webpage (Retrieved from https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/lga-profiler/lga-0). This data is based on 2011 ABS Local Government Area Boundaries (LGA). These data were expressed for 2011 Australian Bureau of Statistics LGAs. Average distance to

mammography service per LGA was compared with average week day trip length reported in the New South Wales Travel Survey, and the difference tested using the Wilcoxon Signed Rank Test. The correlation between LGA average weekday kilometres and average distance for travel to mammography service was also calculated using the Spearman rank correlation. Statistical procedures were conducted using RStudio Version 1.1.456 (RStudio, Inc).

## 3. Results

Travel distance for clients attending mammography services and household travel varies across New South Wales (Table 2). The distance travelled to a mammography service was statistically greater than the average trip length per the New South Wales Travel Survey (4.3 km, 95% CI 3.3 to 5.9 kms, p,0.001). Average trip distance from the New South Wales Travel Survey and distance travelled to attend a mammography service were highly correlated (Spearman rho 0.70, p<0.001).

The only Local Government Area (LGA) where the difference between average week day trip length and average trip length to a mammography service is slightly less (-0.5kms) is Fairfield. The difference between average week day trip length from the New South Wales Travel Survey and average trip length to mammography services is 5kms or less for 30 of the 47 Local Government Areas under review. Shoalhaven and Wingecarribee both have significantly higher average trip lengths to mammography services than for average week day trip length as reported in the New South Wales Travel Survey.

**Table 2. The 2014/2015 Estimated Average Weekday Kilometres Travelled within New South Wales[1], The Average Kilometres New South Wales Cancer Institute Clients Travelled to be Mammography Services[2]**

| Local Government Area Code (2011) | Local Government Area | Avg Trip Length (kms) NSW Travel Survey | NSWCI Client Avg Trip Length | Difference |
|---|---|---|---|---|
| 10150 | Ashfield | 5.7 | 12.7 | 7 |
| 16350 | Auburn | 7.8 | 9.6 | 1.8 |
| 10350 | Bankstown | 7.8 | 9.7 | 1.9 |
| 10750 | Blacktown | 10 | 11.2 | 1.2 |
| 10900 | Blue Mountains | 14.3 | 26.8 | 12.5 |
| 11100 | Botany Bay | 5.5 | 7.2 | 1.7 |
| 11300 | Burwood | 7 | 7.7 | 0.7 |
| 11450 | Camden | 13.2 | 21.8 | 8.6 |
| 11500 | Campbelltown | 11.3 | 14.1 | 2.8 |
| 11520 | Canada Bay | 6.5 | 14.5 | 8 |
| 11550 | Canterbury | 6.7 | 9.9 | 3.2 |
| 12850 | Fairfield | 8.4 | 7.9 | -0.5 |
| 13100 | Gosford | 11.9 | 16.8 | 4.9 |

| | | | | |
|---|---|---|---|---|
| 13800 | Hawkesbury | 15.2 | 29.4 | 14.2 |
| 13950 | Holroyd | 7.5 | 9 | 1.5 |
| 14000 | Hornsby | 9.3 | 13.6 | 4.3 |
| 14100 | Hunters Hill | 8 | 14.8 | 6.8 |
| 14150 | Hurstville | 7.1 | 9.9 | 2.8 |
| 14400 | Kiama | 15.8 | 28.8 | 13 |
| 14450 | Kogarah | 7.2 | 8.5 | 1.3 |
| 14500 | Ku-ring-gai | 7.4 | 12.4 | 5 |
| 14700 | Lane Cove | 7.2 | 8.3 | 1.1 |
| 14800 | Leichhardt | 4.4 | 8.2 | 3.8 |
| 14900 | Liverpool | 10.9 | 13.2 | 2.3 |
| 15150 | Manly | 6 | 12.5 | 6.5 |
| 15200 | Marrickville | 5.8 | 11.5 | 5.7 |
| 15350 | Mosman | 5.5 | 12.2 | 6.7 |
| 15950 | North Sydney | 5.8 | 9.3 | 3.5 |
| 16250 | Parramatta | 8.2 | 9.9 | 1.7 |
| 16370 | Pittwater | 8.3 | 19.5 | 11.2 |
| 16550 | Randwick | 5.6 | 6.6 | 1 |
| 16650 | Rockdale | 7.9 | 8.1 | 0.2 |
| 16700 | Ryde | 8.1 | 12.5 | 4.4 |
| 16900 | Shellharbour | 10.6 | 12.1 | 1.5 |
| 16950 | Shoalhaven | 9.5 | 40 | 30.5 |
| 17100 | Strathfield | 6.8 | 10 | 3.2 |
| 17150 | Sutherland Shire | 9.9 | 12.4 | 2.5 |
| 17200 | Sydney | 4.3 | 9.1 | 4.8 |
| 17420 | The Hills Shire | 10.2 | 11.5 | 1.3 |
| 18000 | Warringah | 7 | 12.6 | 5.6 |
| 18050 | Waverley | 4.6 | 6.2 | 1.6 |
| 18250 | Willoughby | 5.8 | 10.5 | 4.7 |
| 18350 | Wingecarribee | 15.4 | 44.7 | 29.3 |
| 18400 | Wollondilly | 18.7 | 37.8 | 19.1 |
| 18450 | Wollongong | 10.3 | 15.7 | 5.4 |
| 18500 | Woolahra | 4.8 | 8.6 | 3.8 |
| 18550 | Wyong | 13.7 | 20.8 | 7.1 |
| Overall (All LGAs) | Minimum | 4.3 | 6.2 | -0.5 |
| | Maximum | 18.7 | 44.7 | 30.5 |
| | Mean | 8.70 | 14.47 | 5.77 |
| | Median | 7.80 | 12.10 | 3.8 |

*Source*: [1] 2014/2015 Household Travel Survey, [2] New South Wales Cancer Institute.

Mapping the difference between average week day trip length from the New South Wales Travel Survey and the average distance to mammography services in 2011-2013 has revealed that women residing in LGAs south east of Sydney have travelled significantly further than the average week day trip length as reported in the New South Wales Travel Survey (Figure 1). There was also a pattern of greater distance travelled for mammography clients with increased distance from Sydney.

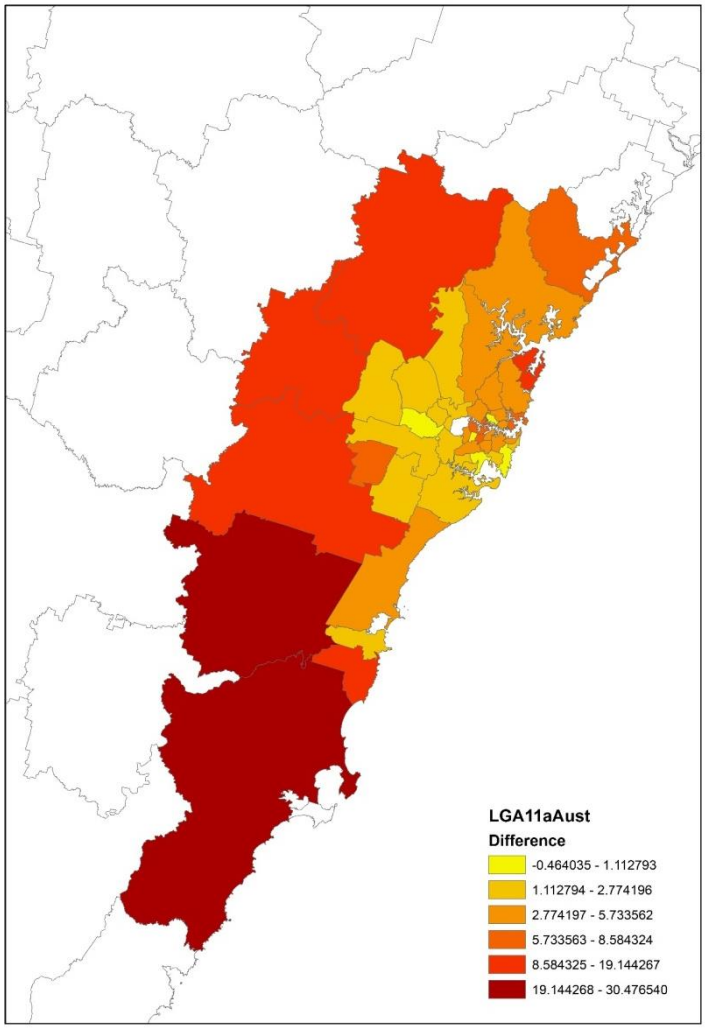


**Figure 1. The Difference in Trip Length in Kilometres between the 2014/2015 Estimated Average Weekday Kilometres Travelled within New South Wales[1] and The Average Kilometres New South Wales Cancer Institute Clients Travelled to Mammography Services[2]**

*Source*: [1] 2014/2015 Household Travel Survey, [2] New South Wales Cancer Institute.

Mapping the average distance that clients have travelled to mammography services in 2011-2013 has highlighted that women in more rural and remote areas of New South Wales are travelling further to access mammography services (Figure 2).

Looking in more detail at the Local Government Area of Shoalhaven which had the largest difference

in average week day trip length from the New South Wales Travel Survey and the average distance that women travelled to mammography services, women can be seen to be travelling to mammography services outside of their Local Government Area (Figure 3). There are also a small number of women travelling significant distances to attend mammography services which are not their closest mammography service. These women are travelling to the metropolitan region of the state to access mammography services.

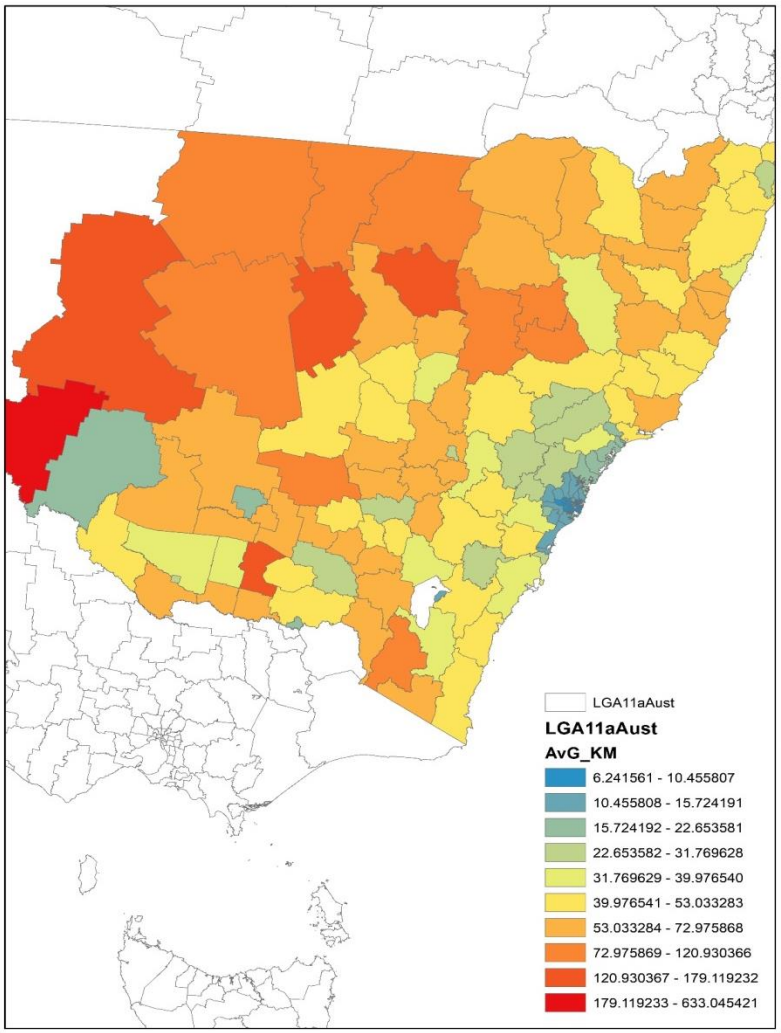


**Figure 2. Average Distance in Kilometres Clients are Traveling to Mammography Services 2011-2013**.

*Source*: New South Wales Cancer Institute.

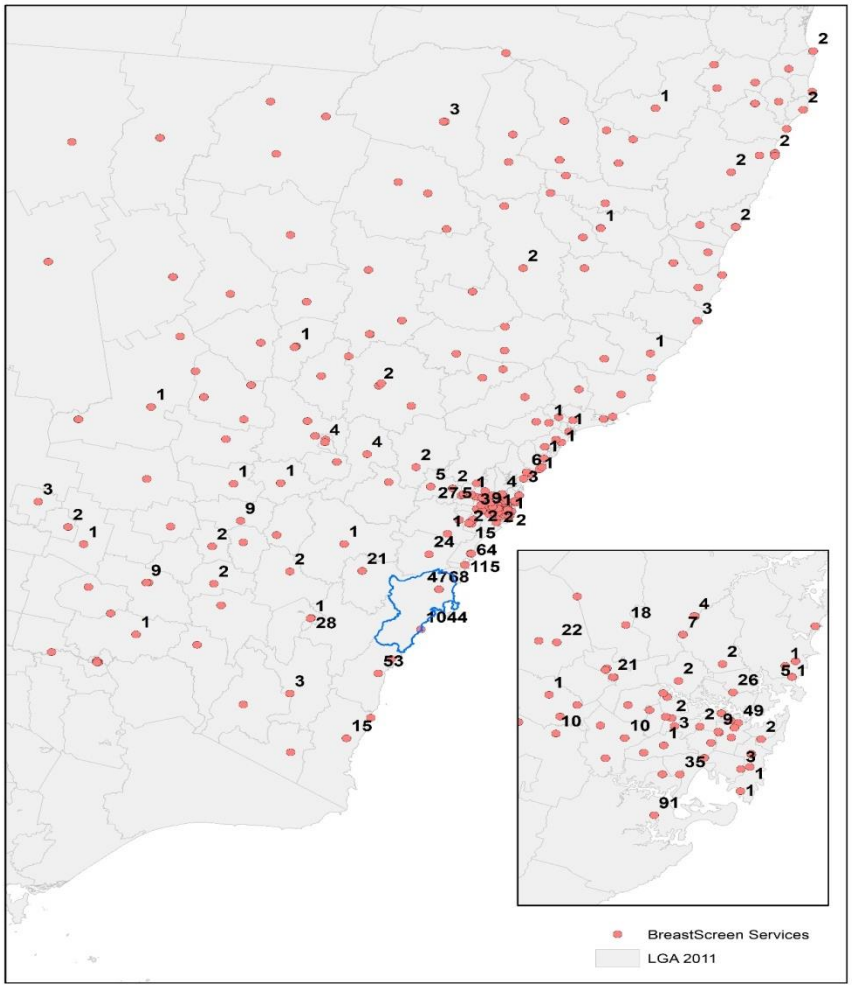


**Figure 3. The Number of Women from Shoalhaven Local Government Area (2011) and the Mammography Service That They Attended in 2011-2013**

*Source*: New South Wales Cancer Institute.

## 4. Discussion

Women aged 50-74, the target population for breast screening experience a range of barriers and enablers to accessing mammography services. The "sandwiching" of this generation of women, who are caring for both the older and the younger generation, is emphasised for women in country areas by the earlier marriage and motherhood of rural women, the disproportionate ageing of the rural population (Warner-Smith et al., 2004). Understanding how these women travel to mammography services is important for future service planning.

This study compared data on average week day trip length distances, to average distances travelled to access mammography services. Average distance travelled to mammography services was overall significantly greater than average week day trip length from the New South Wales Travel Survey. The difference between average week day trip length and client travel distance to mammography services varied spatially, with women south east of Sydney having a greater difference. Importantly distances

travelled to access mammography services were greater for women residing in LGAs further from Sydney and in rural and remote areas of New South Wales. These results reflect differential access to closest mammography services. Mammography services in New South Wales may be either be fixed or mobile with a number of mobile vans visiting different regions. While mobile facilities improve access to mammography services these vans are only present at a site for a limited time period. If a woman wishes to utilize the mammography service at a time when the mobile van is not conveniently located close by, then she may need to travel a considerable distance to another mammography service, especially if she resides in a rural or remote location. The assessment of travel distances for women residing in Shoalhaven suggests this may be the case with some women travelling to metropolitan centres to access mammography services. Therefore, highlighting the burden of travel that some women face when accessing mammography services. This supports the work undertaken by Warner-Smith et al. (2004) who have identified that there are indeed important spatial differences in women's opportunities for health and well-being.

Women's utilization of mammography services outside of their local area may also be due to trip-chaining, where women are combining a series of movements between successive destination choices over a period of time (Thill & Thomas, 1987). This is can be seen in the use of mammography services which are not the closest to the women's residence with some women preferring to utilize services in larger town centres or within the Sydney metropolitan area. These spatial patterns of mammography service use have highlighted that traditional methods of creating spatial catchments at a defined distance around each mammography service may not accurately capture the way women utilize these services in New South Wales. This is supported by research findings from the US with one study reporting only 35% of women attended their closest mammography facility though nearly three quarters of those women not using their closest facility attended a facility within 5 minutes of their closest facility, particularly amongst women living in the urban core (Alford-Teaster et al., 2016).

This study has highlighted the travel distances that some women face when accessing mammography services with higher than average travel distances to ammography services in rural and remote regions of New South Wales. This supports the work undertaken by Warner-Smith et al. (2004) who have identified that there were important spatial differences in women's opportunities for health and well-being. However, further research is needed to understand individual women's decisions on the choice of venue attended for breast screening**.**

## 5. Strengths and Limitations

Geographical software (Network Analyst, ArcGIS) was used to calculate the road distance to the mammography service. This method provides estimates of the distance between the mammography service and the women's residence on the day they were booked for screening. However, some of the women may have travelled to the mammography service from their workplace or other location rather than from home. Such information was not available and could not be accounted for in this analysis.

This study is descriptive in nature and has not assessed the influence of travel distance on screening likelihood or rates, nor has this study assessed other factors that may covary geographically with LGA travel times. Travel distance may not equate to travel time which may be the more pertinent measure in terms of influencing screening behaviour. For example, heavy traffic congestion in dense urban centres may inflate travel time and hinder access.

The strength of this study it its use of residential address and mammography service address geocoding which has enabled estimates of road network travel distances. A further strength is the comparison with average week day trip length, especially given the Australian context where individuals residing in rural and remote areas are accustomed to substantially longer trip lengths in general than individuals residing in major cities. However, this is not to suggest that inequitable access is acceptable, efforts should be made to enable equitable access to all populated regions within Australia.

## 6. Conclusion

Average trip length varies across New South Wales according to LGA, travel distance to access mammography services varies across LGA's. These distances were correlated overall, but the distance travelled to mammography services was longer than the average week day trip length.

This study adds to the literature regarding screening in Australia by identifying that women do not necessarily attend their closest breast mammography service and in general travel further to access the mammography service than their usual week day travel. The distance travelled to mammography services varies across New South Wales and some regions (e.g., South of Sydney) had large differences between household travel and the distance travelled to mammography services. Future research should assess the reasons why women attend a mammography service other than their closest service. This is key for optimising mammography services to meet the needs of the target population and improving screening rates.

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