



The development of a spatial model of accessibility to phase 2 cardiac rehabilitation programs

Deborah van Gaans, Graeme Hugo & Andrew Tonkin

To cite this article: Deborah van Gaans, Graeme Hugo & Andrew Tonkin (2015): The development of a spatial model of accessibility to phase 2 cardiac rehabilitation programs, Journal of Spatial Science, DOI: [10.1080/14498596.2015.1059375](https://doi.org/10.1080/14498596.2015.1059375)

To link to this article: <http://dx.doi.org/10.1080/14498596.2015.1059375>



© 2015 The Author(s). Published by Taylor & Francis



Published online: 17 Nov 2015.



Submit your article to this journal [↗](#)



View related articles [↗](#)



View Crossmark data [↗](#)

The development of a spatial model of accessibility to phase 2 cardiac rehabilitation programs

Deborah van Gaans^{a*} , Graeme Hugo^b and Andrew Tonkin^c 

^a*Centre of Research Excellence in Prevention of Chronic Conditions, School of Population Health, University of South Australia, Adelaide, Australia;* ^b*National Centre for Social Applications of GIS, The University of Adelaide;* ^c*Monash University, Melbourne, Australia*

Existing Phase 2 cardiac rehabilitation services are currently underutilised and improving access will be necessary because of ageing of the population and falling case-fatality rates. The Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation Programs was developed to quantify accessibility to out-patient cardiac rehabilitation in Australia. A geographic information system (GIS) was used to combine both geographic and socio-economic aspects of accessibility. The model was developed by integrating the socio-economic information gathered by survey and incorporating a distance decay model.

Keywords: access; health services; equity

1. Introduction

Over the past century, average Australian mortality rates have fallen significantly, with life expectancies rising for both men and women (Swan 2010). The fall in mortality rates has added to population growth and the proportion of older people in the Australian population. The impending rapid growth of Australia's older population has important implications for provision of services which are particularly needed by older people (Hugo 2010). This challenge is not only because there are many more Australians surviving to old age than in previous generations, but it may well be that on average they are sicker because of a decrease in case-fatality rates and improved survival after acute events (Hugo 2010). This age-associated shift is typified by the burden of cardiovascular disease (CVD), the major public health problem within Australia and many other countries.

Although mortality rates from acute events (heart attack and stroke) have been declining, the burden associated with CVD is enormous and is becoming more associated with chronic disabling illness (notably heart failure or following non-fatal stroke) (Access Economics Pty Ltd 2005). There were an estimated 3.4 million people living with CVD in 2007–08 (Australian Institute of Health and Welfare 2012). CVD occurred more commonly among the elderly, with 62 percent of those aged 75 years and older having a cardiovascular condition compared with 5 percent of those aged under 45 years (Australian Institute of Health and Welfare 2012). The Australian Institute of Health and Welfare (2012) believe that due to improved treatment and management of risk factors for cardiovascular disease the burden of death and disability will shift to older age groups within the Australian population. This age-associated shift, combined with the growing number of older Australians, is

*Corresponding author. Email: deborah.vangaans@unisa.edu.au

likely to add considerably to health care costs in the future.

Cost-effective investment in research, prevention and management in the past decade in Australia has reduced CVD events and mortality rates and arrested growth in health costs over the medium term (Access Economics Pty Ltd 2005). As well as facilitating recovery, cardiac rehabilitation programs function as launching pads for secondary prevention of cardiovascular disease (Goble & Worcester 1999). Cardiac rehabilitation also aims to give people the confidence, motivation and skills to make a lifelong commitment to a healthy lifestyle and greater well-being (National Health and Medical Research Council 2007). However, establishing ongoing community-based approaches is also essential (the National Heart Foundation's Recommended Framework for Cardiac Rehabilitation 2004).

Despite evidence showing the cost-effectiveness of outpatient cardiac rehabilitation, this is still underutilised in Australia (Access Economics 2009). However, Bunker and Goble (2003) have identified that access to cardiac rehabilitation is one of the major factors affecting the utilisation of Phase 2 Cardiac Rehabilitation programs, especially in rural and remote areas within Australia. This is despite the World Health Organisation (1993) and the National Heart Foundation of Australia (2004) recommending that cardiac rehabilitation, incorporating secondary prevention programs, should be available to all patients with cardiovascular disease.

While studies like Clark (2007) highlight the inequitable distribution of cardiovascular services in Australia. Rosenberg and Hanlon (1996) have argued that the existence of a health care facility within a geographic location is not enough to ensure access. This is because barriers to accessing cardiac rehabilitation services are not just related to physical distance and the availability of reliable transport (National Health and Medical Research Council 2007). Therefore there is a need to

measure accessibility beyond distance, as accessibility based on travel time, cost or distance only provides a partial view of access to services. In reality, people trade off geographical and non-geographical factors in making decisions about health service utilisation (Cromley & McLafferty 2002).

The Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation Programs described here has utilised Penchansky and Thomas's (1981) dimensions of accessibility as a framework by spatially modelling the accessibility, availability, accommodation, affordability and acceptability of each Phase 2 cardiac rehabilitation program in Australia. The spatial accessibility model for Phase 2 cardiac rehabilitation was created using ESRI ArcGIS version 9.3.1, ESRI Network Analyst. The results from the Cardiac Accessibility Survey for the socio-economic dimensions of accessibility as defined by Penchansky and Thomas (1981) were combined to give an overall rating of accessibility for each of the Phase 2 cardiac rehabilitation programs that responded to the survey. The overall accessibility rating for each of the Phase 2 cardiac rehabilitation programs was then combined with the road network from Geoscience Australia and the distance decay curve of patients attending cardiac rehabilitation, to construct accessibility raster cost distance surfaces along the road network from each of the Phase 2 cardiac rehabilitation programs.

2. Method

A review of available literature on barriers to the uptake of cardiac rehabilitation services within Australia was undertaken. Using Penchansky and Thomas's (1981) five dimensions of accessibility as a structural framework, the information obtained from the literature review was used to form a series of questions (see Table 1). The questions were both open-ended and closed. These questions were then organised into a formal questionnaire which

Table 1. Methodology for developing the Cardiac Rehabilitation Accessibility Survey.

Penchansky and Thomas (1981) dimensions of access:	Reference	Cardiac Rehabilitation Accessibility Survey Question
Accessibility – describes geographical barriers, including distance, transportation, travel time, and cost.	<p>‘Living an average of 27 km away compared to an average of 47 km.’ Schulz and McBurney (2000)</p> <p>Compared with non-attendees, patients who attended CR had a significantly shorter travel time (mean difference, 5.31 min [95% CI, 0.81–9.81 min]; $F1,159 = 5.42$; $P = .021$), lived closer to the program venue (mean difference, 5.53 km [95% CI, –0.22 to 11.27 km]. Higgins <i>et al.</i> (2008)</p> <p>Patients were less likely to attend CR as travel time increased: 1 min of extra travel time was associated with a 14% reduction in the likelihood of attendance, and 10 min of extra travel time corresponded to a 77% reduction. Higgins <i>et al.</i> (2008)</p> <p>This is highlighted by the fact that attendees lived an average of 15.4 km from the facility providing the CR program whereas non-attenders lived an average of 40.4 km from the facility. Easy access to transport is a principal enabler of CR attendance. De Angelis <i>et al.</i> (2008)</p> <p>Aikman <i>et al.</i> (1996) found the patient characteristics that influenced attendance were ‘wanting to attend’, ‘partner wanting to attend’ and ‘living less than 15 km from the program’.</p> <p>‘Many CR programs have an age limit on attendance.’ Schulz and McBurney (2000), Pell <i>et al.</i> (1996) and McGee <i>et al.</i> (1992)</p> <p>‘Exclusions were on the basis of age, a positive exercise tolerance test, post-infarct angina or heart failure, despite the fact they may have benefitted the most from exercise cardiac rehabilitation.’ Tod <i>et al.</i> (2002)</p> <p>‘The most significant factor in the prediction of CR attendance was referral to the program.’ Schulz and McBurney (2000)</p>	<p>Program location (where do patients go to access your program): Street: Suburb: Town/city: Postcode:</p> <p>Which of the following age groups do you allow to use your cardiac rehabilitation program? All ages, <15, 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, 85+.</p> <p>According to discharge diagnosis, what type of patients do you allow into your cardiac rehabilitation program ? (please tick all of those that apply).</p> <p>Do the people that utilise your cardiac rehabilitation program require a referral? (please circle) Yes / No. If Yes, where do people usually get referred from?</p>

Table 1. (Continued)

Accommodation – identifies the degree to which services are organised to meet clients’ needs, including hours of operation, application procedures and waiting times.	<p>‘Some patients interpreted cardiac rehabilitation as exercise only. This was a barrier when people did not see exercise for them.’ Tod <i>et al.</i> (2002)</p> <p>‘The provision of home as well as hospital-based CR may be an important means of addressing the suboptimal uptake of CR after MI.’ Wingham <i>et al.</i> (2006)</p> <p>Some participants advocated the delivery of education and exercise in a group setting. Others found it inappropriate and unappealing. Tod <i>et al.</i> (2002)</p> <p>‘Home-based CR models have the most substantive evidence base and therefore the greatest potential to be developed and made accessible to eligible people living in rural and remote areas.’ Dollard <i>et al.</i> (2004)</p> <p>‘Reasons for not participating include lack of time, lack of referral or physician support, financial reasons, lack of motivation, perceptions of the benefits, distance and transportation, family composition, nature of the program and work commitments.’ Shepherd <i>et al.</i> (2003).</p> <p>Patients on a low income or who are socially deprived are less likely to attend but, as with the elderly or female patients, may have the most to gain from secondary prevention because there is a linear relationship between socioeconomic status and cardiac outcome. Cooper <i>et al.</i> (2002)</p> <p>‘While the evidence underpinning cardiac rehabilitation suggests that it can be of benefit, poor attendance rates mean that services often fail to help those in need.’ Clark <i>et al.</i> (2004).</p>	<p>Which of the following are included in your cardiac rehabilitation program (please tick all that apply)? Health education, physical activity, counselling, behaviour modification strategies, support for self-management, cultural understanding.</p> <p>Within what type of setting is the cardiac rehabilitation program run (tick all that apply): within an acute public hospital, within an acute private hospital, within an Aboriginal Medical Service, within a non-acute/community hospital, within a public community health centre/service, within a private outpatient service, as part of an outreach service to communities, telephone service, home visits, internet.</p> <p>What type of sessions do you provide? Group only, individual only, group and individual.</p> <p>When is your cardiac rehabilitation program available to patients (please indicate operating hours):</p> <p>Is there a cost associated with attending your cardiac rehabilitation program that is not covered by medicare? Yes / No. If Yes, what is the cost?</p> <p>How many patients participated in your cardiac rehabilitation program in the last financial year (2007/2008)?</p> <p>How many patients completed your cardiac rehabilitation program in the last financial year (2007/2008)?</p>
Affordability – refers to the price of services in regard to people’s ability to pay.		
Acceptability – describes clients’ views of health services and how service providers interact with clients.		

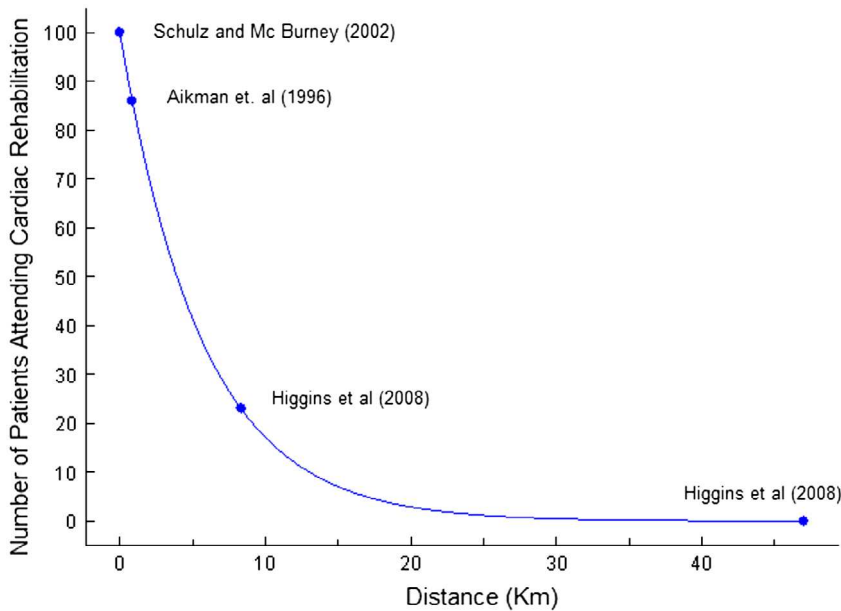


Figure 1. The Distance Decay of Patients Attending Cardiac Rehabilitation.

was sent to each of the cardiac rehabilitation programs within Australia ($n = 401$).

The names and addresses of these cardiac rehabilitation services were obtained from both a register developed by the National Heart Foundation of Australia (NHF) and the Australian Government National Health and Medical Research Council's report 'Geographic Information System of Cardiac Rehabilitation Services for Aboriginal and Torres Strait Islander Peoples' (2007). The address lists were combined and duplicates were removed.

An initial pilot survey was undertaken in July 2008, using a subsample of 20 cardiac rehabilitation services from the total population ($n = 401$). The cardiac rehabilitation services were chosen at random and were used to test the suitability of the Cardiac Rehabilitation Accessibility Survey questionnaire and the method of its delivery. The questionnaires were sent to the rehabilitation coordinators for each cardiac rehabilitation service via email. Only three questionnaires were returned and

12 of the emails that were sent no longer had valid email addresses. As a result of the poor response rate from the pilot testing, traditional post was considered to be the preferred method of survey delivery.

In October 2008 a postal survey of all 401 cardiac rehabilitation services in Australia was undertaken to collect information on the accessibility of their Phase 2 cardiac rehabilitation programs for the 2007/2008 financial year. Every cardiac rehabilitation program was mailed a questionnaire and given 3 weeks to return it in a pre-paid envelope. Incentive for the return of the questionnaire was provided by 'The Heart Shop' in the form of a polar heart rate monitor. This was given at random to one of the cardiac rehabilitation services that returned their questionnaire. A total of 39 cardiac rehabilitation services did not reply to the questionnaire. These services were given a follow-up phone call requesting information but they were still unable to provide information. Many of the cardiac rehabilitation coordinators for these services stated that they did

not have the time to fill out the questionnaire ($n = 28$), that they did not run a Phase 2 cardiac rehabilitation program ($n = 9$), or could just not be contacted ($n = 2$). The return rate for the questionnaire was 84 percent, with 362 responses being returned; however, 158 of the questionnaires that were returned stated that they did not manage a formal Phase 2 cardiac rehabilitation program. This resulted in a total of 204 questionnaires being available for analysis. Using the data from the Cardiac Rehabilitation Accessibility Survey each program was assessed based on the theory of accessibility developed by Penchansky and Thomas (1981), which included the following five dimensions of access:

- a. Accessibility – describes geographical barriers, including distance, transportation, travel time and cost.
- b. Availability – defines the supply of services in relation to needs – are the types of services adequate to meet health care needs?
- c. Accommodation – identifies the degree to which services are organised to meet clients' needs, including hours of operation, application procedures and waiting times.
- d. Affordability – refers to the price of services in regard to people's ability to pay.
- e. Acceptability – describes client's views of health services and how service providers interact with clients.

Accessibility

A well-documented barrier to accessing cardiac rehabilitation programs is the distance patients are required to travel to obtain the service, with those who have further to travel not attending (Johnson *et al.* 2001, p. 294). Aikman *et al.* (1996) found the patient characteristics that influenced attendance were 'wanting to attend', 'partner wanting to attend' and 'living less than 15 km from the

program'. Similar findings were found by Schulz and McBurney (2000), who identified that the factors that predicted cardiac rehabilitation attendance in 93.6 percent of cases were being referred to the program, living an average of 27 km away compared to an average of 47 km, living with a partner and being male. Higgins *et al.* (2008) found that patients were less likely to attend CR as travel time increased: 1 min of extra travel time was associated with a 14 percent reduction in the likelihood of attendance, and 10 min of extra travel time corresponded to a 77 percent reduction. Higgins *et al.* (2008) found that travel time significantly predicted CR attendance (OR, 0.86; $P = .039$). Research by Brual *et al.* (2010) revealed that patients are significantly less likely to enrol in cardiac rehabilitation programs with drive times greater than 60 min. Higgins *et al.* (2008) found similar results, with patients who attended CR having a significantly shorter travel time (mean difference, 5.31 min [95 percent CI, 0.81–9.81 min]; $F_{1,159} = 5.42$; $P = .021$), living closer to the program venue (mean difference, 5.53 km [95 percent CI, –0.22 to 11.27 km]; $F_{1,159} = 3.61$; $P = .059$). Geographic accessibility (which Penchansky and Thomas (1981) refer to as 'accessibility') for the Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation was derived by constructing a distance decay model. If travel times only were published then they were converted, using 60 km/h, to a distance. The distances were fitted to a curve within Microsoft Excel and XLfit and an exponential curve representing the distance decay of patients attending cardiac rehabilitation was created (refer to Figure 1).

The street addresses for each Phase 2 cardiac rehabilitation program were obtained through the Cardiac Rehabilitation Accessibility Survey. Using Aus-emaps.com Manual Geocoder each Phase 2 cardiac rehabilitation program was given a spatial reference.

Availability

Availability as defined by Penchansky and Thomas (1981) is the supply of services in relation to needs. Therefore the availability rating component of each Phase 2 cardiac rehabilitation program within the spatial model was calculated using the following formula:

$$a = (b + c + d)/e$$

where:

a = availability rating of the Phase 2 cardiac rehabilitation program,

b = referral required to enter the program,

c = the percentage of diseases accepted into the program,

d = age range accepted into the program,

e = the total number of availability components.

Referral to the Phase 2 cardiac rehabilitation program was seen by Schulz and McBurney (2000) as the most significant factor in the prediction of cardiac rehabilitation attendance. Using the results from the Cardiac Rehabilitation Accessibility, Phase 2 cardiac rehabilitation programs that answered yes to 'Do the people that utilise your cardiac rehabilitation program require a referral to access your program?' were given a score of 1.

Availability of cardiac rehabilitation is also affected by patient clinical characteristics. Tod *et al.* (2002) found that exclusions were often based on age, a positive exercise tolerance test, presence of angina following myocardial infarction (heart attack) or heart failure. Defining which coronary heart disease patients should be accessing Phase 2 cardiac rehabilitation programs was determined by one of the authors (AMT) with reference to the National Heart Foundation of Australia and the Australian Cardiac Rehabilitation Association's, 'Recommended Framework for Cardiac Rehabilitation '04'. They recommended that the core group of patients eligible for cardiac rehabilitation are those who have had myocardial infarction (ST elevation MI, non-ST

elevation MI), coronary revascularisation procedures, stable or unstable angina, controlled heart failure, or other vascular or heart diseases (National Heart Foundation and ACRA 2004). Disease codes and their associated descriptions were obtained from the South Australian Department of Health and codes which matched the National Heart Foundation and the Australian Cardiac Rehabilitation Association's recommendations were used in the Cardiac Rehabilitation Accessibility Survey. Responses to the Cardiac Rehabilitation Accessibility Survey question 'According to discharge diagnosis, what types of patients do you allow into your cardiac rehabilitation program? (please tick all of those that apply)' were represented as a percentage within the spatial model.

The age of patients able to access cardiac rehabilitation programs was also included in the availability component of the spatial model. Pell *et al.* (1996), McGee *et al.* (1992) and Schulz and McBurney (2000) found that many cardiac rehabilitation programs have an age limit on attendance. However, results from the Cardiac Rehabilitation Accessibility Survey revealed that 67 percent of the Phase 2 cardiac rehabilitation programs accepted patients of all ages. The Phase 2 cardiac rehabilitation programs that allowed only specific age groups into their programs were represented as a percentage of the total age allowed into the program in the spatial model.

Accommodation

Accommodation was defined by Penchansky and Thomas (1981) as the degree to which services are organised to meet clients' needs. Therefore the accommodation rating component of each Phase 2 cardiac rehabilitation program within the spatial model was calculated using the following formula:

$$a = (b + c + d + e + f + g + h + i + j + k + l + m)/n$$

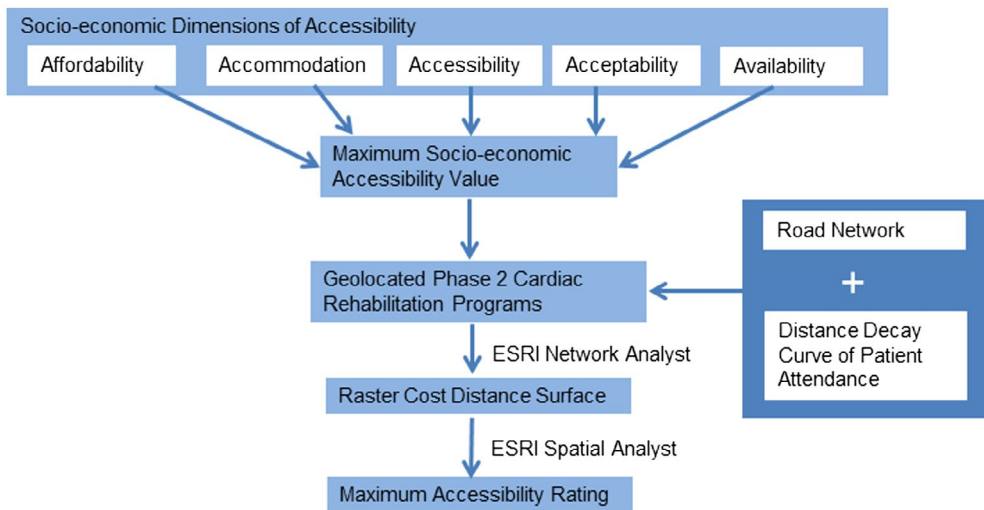


Figure 2. The Method that was Undertaken to Determine the Accessibility of Phase 2 Cardiac Rehabilitation Programs in Australia.

where:

- a = accommodation rating of the Phase 2 cardiac rehabilitation program,
- b = program contained health education,
- c = program contained physical activity,
- d = program contained counselling,
- e = program contained behaviour modification,
- f = program contained self-support management,
- g = program contained cultural understanding,
- h = program is delivered in a group and individual setting,
- i = program is delivered via a telephone service,
- j = program is delivered via home visits,
- k = program is delivered via internet,
- l = program is run after hours,
- m = program is delivered via post,
- n = the total number of accommodation components

The National Heart Foundation of Australia and the Australian Cardiac Rehabilitation Association's, 'Recommended Framework for Cardiac Rehabilitation '04' recommends that a

Phase 2 cardiac rehabilitation program should consist of: health education, physical activity, counselling, behaviour modification, support of self-management and cultural understanding. These components of Phase 2 cardiac rehabilitation programs were included in the Cardiac Rehabilitation Accessibility Survey, and respondents were asked to tick all of the components that applied to their program. Aspects were equally weighted and scored for a positive response, and the sum was included in the spatial model.

The setting in which the Phase 2 cardiac rehabilitation program is delivered can also be considered an accommodation component of the spatial model. Results from the Cardiac Rehabilitation Accessibility Survey for the question 'Within what type of setting is the cardiac rehabilitation program run: (tick all that apply)' were used. The Phase 2 cardiac rehabilitation program coordinators were asked to select from the following settings: acute public hospital, acute private hospital, Aboriginal Medical Service, non-acute/community health centre/service, private outpatient service, outreach service to communities,

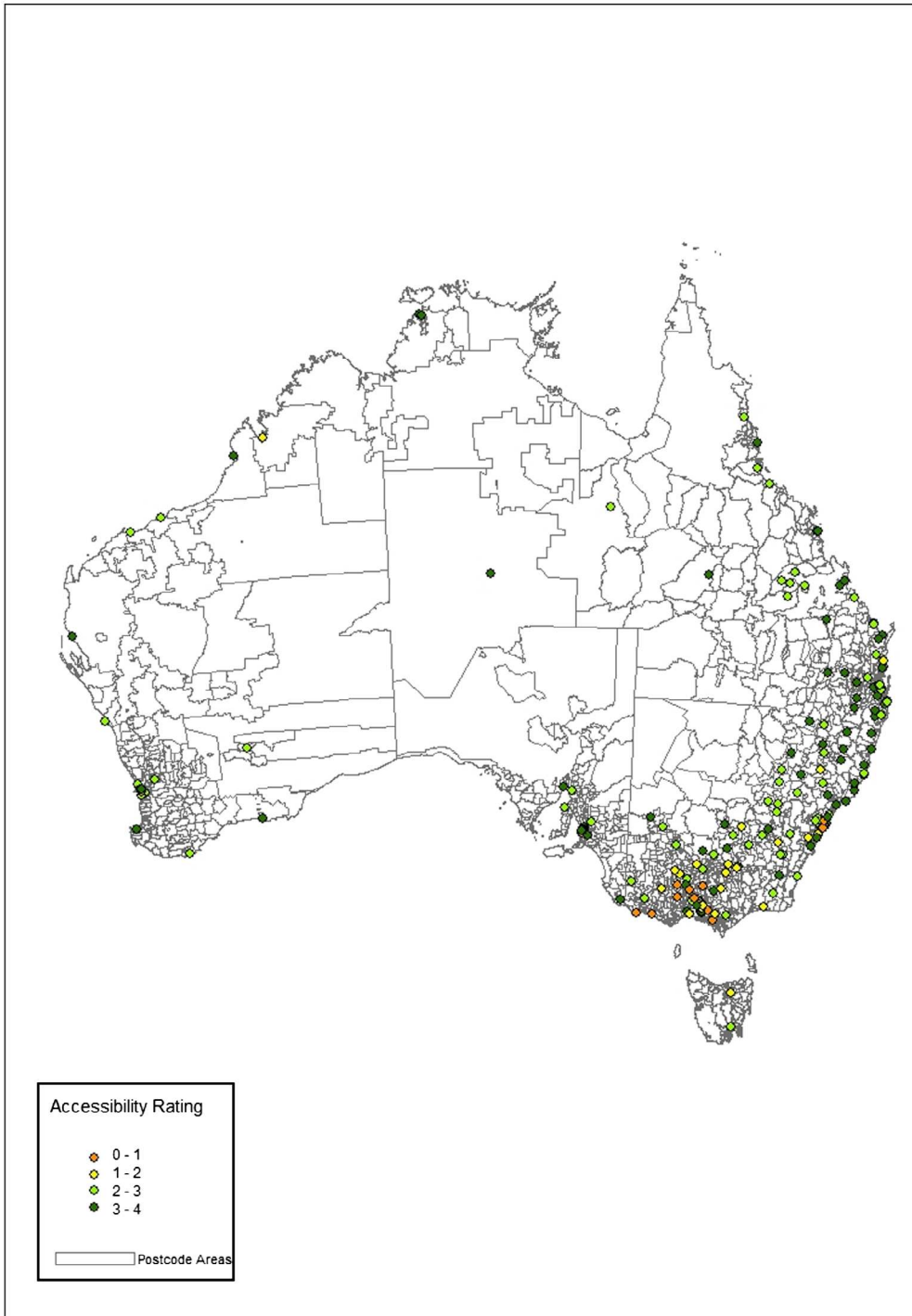


Figure 3. The Accessibility of Phase 2 Cardiac Rehabilitation Programs in Australia.

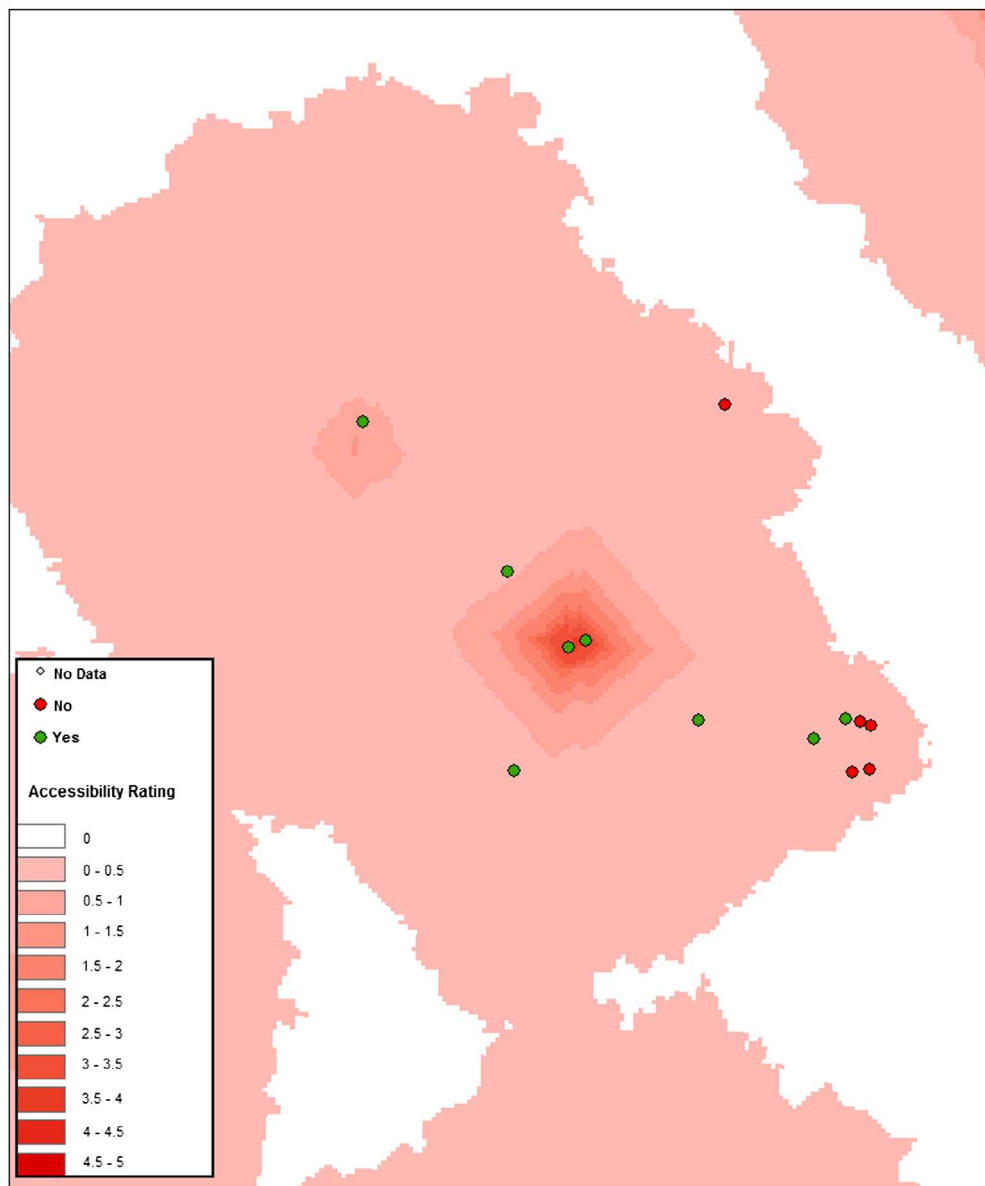


Figure 4. Results from the Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation Programs Overlaid with Patient Attendance and Non-attendance to Cardiac Rehabilitation.

telephone service, home visits, internet, postal contact, or other. Most of the Phase 2 cardiac rehabilitation programs chose a number of these settings.

Tod *et al.* (2002) found that some participants advocated the delivery of education

and exercise in a group setting, others found it inappropriate and unappealing. The Cardiac Rehabilitation Accessibility Survey gathered information on whether the Phase 2 cardiac rehabilitation programs ran group only, individual only, women only, and group and

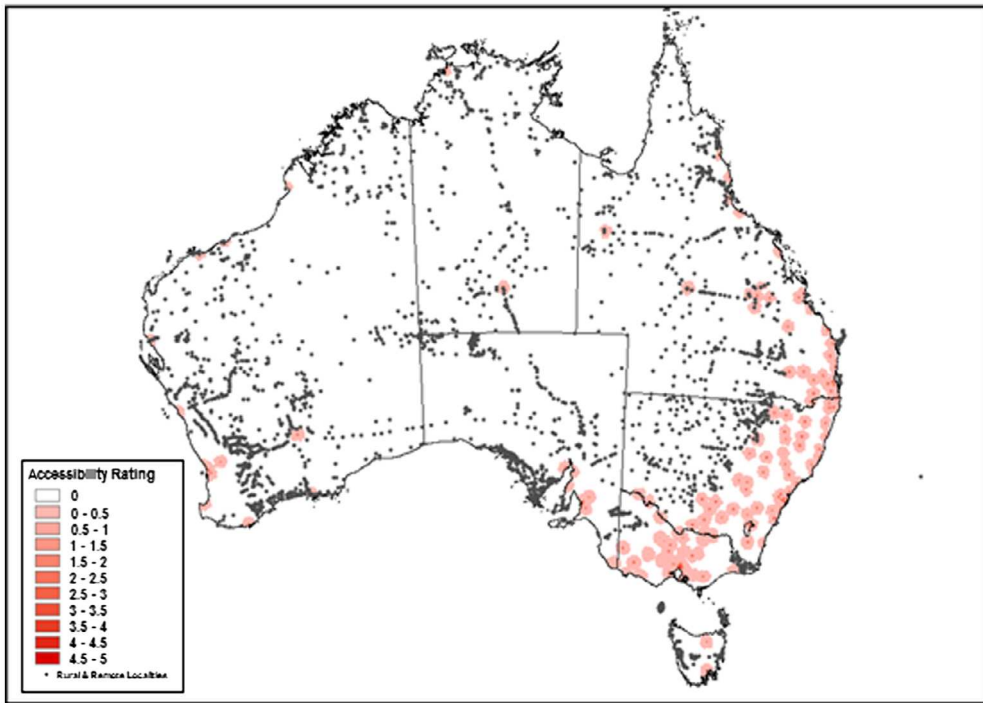


Figure 5. The Accessibility of Phase 2 Cardiac Rehabilitation Programs in Australia 2007/2008.

individual sessions. Information from the survey was included in the spatial model.

Affordability

The cost of cardiac rehabilitation can be seen as a barrier to many patients. Patients on a low income or who are socially deprived are less likely to attend but, as with elderly or female patients, may have the most to gain from secondary prevention because there is a linear relationship between socioeconomic disadvantage and subsequent outcome (Cooper *et al.* 2002).

Affordability for the spatial model was derived from the data obtained from the Cardiac Rehabilitation Accessibility Survey from the following question: 'Is there a cost associated with attending your cardiac rehabilitation program that is not covered by medicare?

(please circle) Yes / No. If Yes, what is the cost?' Therefore the affordability rating component of each Phase 2 cardiac rehabilitation program within the spatial model was calculated using the following formula:

$$a = (b - c)$$

where:

a = affordability rating of the Phase 2 cardiac rehabilitation program,

b = free service,

c = extra cost,

$$\text{Affordability} = (\text{free service} - \text{extra cost})$$

The extra costs that were identified through the survey ranged from a gold coin donation per session to \$60 per session. Gold coin donations were not seen as incurring an extra cost in the spatial model.

Acceptability

Penchansky and Thomas (1981) describe acceptability as the client's views of health services and how service providers interact with clients. Clark *et al.* (2004) state that while the evidence underpinning cardiac rehabilitation suggests that it can be of benefit, poor attendance rates mean that services often fail to help those in need. Therefore the completion rate of patients participating in a Phase 2 cardiac rehabilitation program would provide a view of the acceptance of the program by the patients. In the spatial model the acceptability rating component was derived by calculating the percentage of all patients who enrolled and completed the program.

Spatial modelling

The spatial accessibility model for Phase 2 cardiac rehabilitation was created using ESRI ArcGIS version 9.3.1, ESRI Network Analyst (Figure 2). The results from the Cardiac Accessibility Survey for the socio-economic dimensions of accessibility as defined by Penchansky and Thomas (1981) were combined to give an overall rating of accessibility for each of the Phase 2 cardiac rehabilitation programs across Australia that responded to the survey (Figure 3). This included a rating for the programs' availability, accommodation, affordability and acceptability. The overall accessibility ratings for each of the Phase 2 cardiac rehabilitation programs were then combined with the road network from Geoscience Australia and the distance decay curve of patients attending cardiac rehabilitation to construct accessibility raster cost distance surfaces along the road network from each of the Phase 2 cardiac rehabilitation programs. Rasters for each of the Phase 2 cardiac rehabilitation programs were then overlaid and ESRI's Spatial Analyst was used to show the maximum accessibility value for each cell.

Model validation

Patient attendance data were obtained from The Heart Research Centre, Melbourne, Australia. The patient attendance data comprised 118 coronary artery bypass graft surgery (CABGS) patients from the Royal Melbourne Hospital between July 2001 and April 2004 (Higgins *et al.* 2008, p. 712). Patients were excluded from the data set if they were over 85 years of age, were subsequently assigned to a non-CABGS procedure, or failed to return the questionnaire before surgery. Cardiac rehabilitation attendance was defined as having attended at least one cardiac rehabilitation session and was confirmed by contacting the relevant cardiac rehabilitation program coordinators (Higgins *et al.* 2008, p. 712).

The results from the Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation Programs were overlaid with the locations of patients who attended and those who did not attend Phase 2 cardiac rehabilitation and accessibility values were obtained for each of the patient locations. Patients with higher accessibility ratings from the Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation were found to have been more likely to have attended cardiac rehabilitation (Pearson correlation .308 ($P > .0001$, 95 percent CI .1350 to .4632). The correlation between patient attendance at cardiac rehabilitation and the accessibility rating from the Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation can also be seen spatially in Figure 4. This figure clearly shows that as accessibility to the cardiac rehabilitation program decreases patient non-attendance occurs.

3. Results

The Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation Programs has combined a synthesis of published cardiac rehabilitation literature on the barriers to accessing

cardiac rehabilitation through a theoretical framework of accessibility with a geographical information system (GIS) to create a practical methodology which can be used to measure the accessibility to Phase 2 cardiac rehabilitation. By using the Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation Programs with data obtained from the Cardiac Rehabilitation Accessibility Survey it has been possible to measure the accessibility of Phase 2 cardiac rehabilitation programs within Australia.

The model has revealed that the accessibility of Phase 2 cardiac rehabilitation programs in 2007/08 was extremely variable across Australia. As can be seen in Figure 5, most rural and remote localities in Australia had no access to Phase 2 cardiac rehabilitation programs and access to programs in metropolitan areas in some areas is also low despite services being available.

This research has shown that while studies like Clark *et al.* (2007) highlight the inequitable distribution of cardiovascular services in Australia, barriers to accessing cardiac rehabilitation services are not just related to physical distance and the availability of reliable transport (National Health and Medical Research Council 2007). Accessibility to cardiac rehabilitation is a multifaceted phenomenon with both geographic and socio-economic factors influencing the accessibility of the service.

4. Discussion

While there have been a number of methodologies developed for measuring the geographical accessibility of cardiac services, there have been no methodologies that have incorporated socio-economic and geographic aspects of accessibility for cardiac rehabilitation services. This research has therefore provided a new perspective to measuring accessibility to Phase 2 cardiac rehabilitation and has highlighted that it is possible to apply the theoretical concepts of accessibility to create, a practical spatial

model of accessibility to Phase 2 cardiac rehabilitation programs within Australia.

By spatially modelling the accessibility, availability, accommodation, affordability and acceptability to each Phase 2 cardiac rehabilitation program, it is possible to identify areas where accessibility to cardiac rehabilitation could be improved. The spatial accessibility model for Phase 2 cardiac rehabilitation provides health service planners with new information on the accessibility of outpatient cardiac rehabilitation within Australia. The model has been used to identify areas where accessibility to these programs could be improved and where new programs or models of delivery should be established to enhance accessibility in areas that are currently poorly served. Improving access to Phase 2 cardiac rehabilitation will be necessary to cope with an ageing population and falling cardiovascular death rates.

The development of the Spatial Model of Accessibility of Phase 2 Cardiac Rehabilitation has highlighted the complexity and multi-dimensional nature of defining and measuring accessibility to health services and has emphasised that the concept of accessibility is more than a measure of distance from a health service to a population. The development of the Spatial Model of Accessibility to Phase 2 Cardiac Rehabilitation has shown that it is possible to include both socio-economic and geographical components to create a tool to measure accessibility. While this study has focused on measuring the accessibility to Phase 2 cardiac rehabilitation programs within Australia, the methodology behind the model could be utilised to develop similar spatial models to measure accessibility to Phase 2 cardiac rehabilitation in other countries and for measuring access to other services.

Results from this study also highlight the need for further research into the issues between service users and providers within the field of health service provision. The Spatial Model of

Accessibility to Phase 2 Cardiac Rehabilitation Programs that was developed as part of this study is currently only a general model. Further refinements to the model could be made so that the accessibility to Phase 2 cardiac rehabilitation programs could be measured depending on the characteristics of the individual users. For example pensioners and professionals who want to access a Phase 2 cardiac rehabilitation program will consider different issues as barriers to accessing the service, therefore enhancing the existing model to incorporate a number of different user types would provide an even better measure of the accessibility of the service to the users whom they are attempting to support.

Acknowledgements

The research reported in this paper has been supported by the Australian Primary Health Care Research Institute, which is supported by a grant from the Commonwealth of Australia as represented by the Department of Health and Ageing. The information and opinions contained in it do not necessarily reflect the views or policy of the Australian Primary Health Care Research Institute or the Commonwealth of Australia (or the Department of Health and Ageing).

Funding

This research project was supported by Cardiac-ARIA: an Australian Research Council Funded Linkage Project with collaborating partners Alphapharm Pty. Ltd., The University of Adelaide, University of South Australia, University of Queensland, Monash University and The Baker Heart Research Institute.

ORCID

Deborah van Gaans  <http://orcid.org/0000-0001-8725-5310>

Andrew Tonkin  <http://orcid.org/0000-0001-5291-0610>

References

- Access Economics. 2009. *The economic costs of heart attack and chest pain (acute coronary syndrome)*. Access Economics Pty Ltd, Canberra, ACT.
- Access Economics Pty Ltd., 2005. *The Shifting Burden of Cardiovascular Disease in Australia*. West Melbourne, Victoria: National Heart Foundation of Australia.
- Aikman, H., McBurney, H., and Bunker, S. 1996. Cardiac rehabilitation: the extent, reasons and predictors of patient non-attendance. Proceedings of VI World Congress of Cardiac Rehabilitation, Buenos Aires, Argentina.
- Australian Institute of Health and Welfare. 2012. *Australia's health 2012*. Australia's health series no.13. Cat. no. AUS 156. Canberra: AIHW.
- Bruhal J, Gravely-Witte S, Suskin N, Stewart DE, Macpherson A, Grace SL, 2010, 'Drive Time to Cardiac Rehabilitation: At What Point Does it Affect Utilization?', *International Journal of Health Geographics*, 9:27 <http://www.ij-health-geographics.com/content/9/1/27>.
- Bunker, S.J. and Goble, A.J., 2003. Cardiac rehabilitation: under-referral and underutilisation. *Medical Journal of Australia*, 179, 332–333.
- Clark, A.M., Barbour, R.S., White, M. and MacIntyre, P.D., 2004. Promoting participation in cardiac rehabilitation: patient choices and experiences. *Journal of Advanced Nursing*, 47, 5–14. doi:10.1111/j.1365-2648.2004.03060.x.
- Clark, R.A., Driscoll, A., Nottage, J., McLennan, S., Coombe, D.M., Bamford, E.J., Wilkinson, D. and Stewart, S., 2007. Inequitable provision of optimal services for patients with chronic heart failure: a national geo-mapping study. *Medical Journal of Australia*, 186 (4), 169–173.
- Cooper, A.F., Jackson, G., Weinman, J. and Horne, R., 2002. Factors associated with cardiac rehabilitation attendance: a systematic review of the literature. *Clinical Rehabilitation*, 16, 541–552.
- Cromley, E.K. and McLafferty, S.L., 2002. *GIS and public health*. New York, NY: A division of Guilford Publications Inc, The Guilford Press.
- De Angelis C, Bunker S, and Schoo A, 2008, 'Exploring the Barriers and Enablers to Attendance at Rural Cardiac Rehabilitation Programs', *Australian Journal of Rural Health*, 16(3), pp.137–142.
- Dollard J, Smith J, Thompson DR, Stewart S, 2004, 'Broadening the Reach of Cardiac Rehabilitation to Rural and Remote Australia', *European Journal of Cardiovascular Nursing*, 3, pp.27–42.
- Goble, A.J. and Worcester, M.U.C., 1999. *Best practice guidelines for cardiac rehabilitation and secondary prevention*. Victoria, Australia: Department of Human Services.
- Health and Medical Research Council. 2007. *Geographic information system of cardiac rehabilitation services for aboriginal and torres strait islander peoples*. Canberra, ACT, Australian Government.

- Higgins, R.O., Murphy, B.M., Goble, A.J., Le Grande, M.R., Elliot, P.C. and Worcester, U.C., 2008. Cardiac rehabilitation program attendance after coronary artery bypass surgery: overcoming the barriers. *Medical Journal of Australia*, 188, 712–714.
- Hugo, G., 2010. *Demographic change and liveability panel report*, in a sustainable population strategy for Australia, department of sustainability, environment, water, population and communities. Australian Government Commonwealth of Australia, Canberra, ACT.
- Johnson J E, Weinert C, and Richardson JK, 2001, 'Rural Residents Use of Cardiac Rehabilitation Programs' , *Public Health Nursing*, 15(4), pp. 288–296.
- McGee, H.M. and Horgan, J.H., 1992. Cardiac rehabilitation programmes: are women less likely to attend? *British Medical Journal*, 305, 283–284.
- National Heart Foundation and Australian Cardiac Rehabilitation Association, 2004. *Recommended framework for cardiac rehabilitation '04*. Melbourne, Victoria: National Heart Foundation.
- Pell, J., Pell, A., Morrison, C., Blatchford, O. and Dargie, H., 1996 Retrospective study of influence of deprivation on uptake of cardiac rehabilitation. *BMJ*. 1996 August 3; 313 (7052), 267–268.
- Penchansky, R. and Thomas, J.W., 1981. The concept of access: definition and relationship to consumer satisfaction. *Medical Care*, 19 (2), 127–140.
- Rosenberg, M. and Hanlon, N., 1996. Access and utilization: a continuum of health service environments. *Social Science and Medicine*, 43 (6), 975–983.
- Schulz, D.L. and McBurney, H., 2000. Factors which influence attendance at a rural Australian cardiac rehabilitation program. *Coronary Health Care*, 4, 135–141.
- Shepherd F, Battye K, Chalmers E, 2003, 'Improving Access to Cardiac Rehabilitation for Remote Indigenous Clients', *Australian and New Zealand Journal of Public Health*, 27(6), pp. 632–636.
- Swan, W., 2010. *Australia to 2050: future challenges* commonwealth of Australia. Barton Australian Capital Territory. Canberra, ISBN 978-0-642-74576-7.
- Tod, A.M., Lacey, E.A. and McNeill, F., 2002. "I'm still waiting..": barriers to accessing cardiac rehabilitation services. *Journal of Advanced Nursing*, 40 (4), 421–431.
- World Health Organisation, 1993, *Report of expert committee on rehabilitation after cardiovascular disease*. WHO Technical Report Series No. 831. Geneva: World Health Organization.
- Wingham J, Dalal HM, Sweeney KG, Evans PH, 2006, 'Listening to Patients: Choice in Cardiac Rehabilitation', *European Journal of Cardiovascular Nursing*, pp. 289–294.