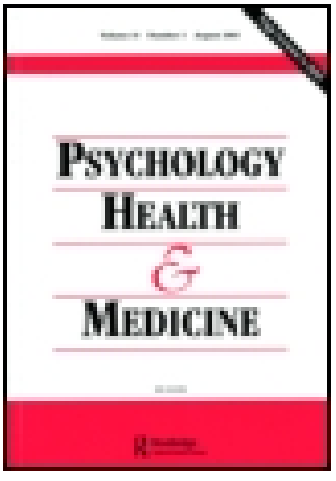

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A comparison of health behaviours in lonely and non-lonely populations

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A comparison of health behaviours in lonely and non-lonely populations

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Abstract
Loneliness can be defined as perceived social isolation and appears to be a relatively common experience in adults. It carries a significant health risk and has been associated with heart disease, depression and poor recovery after coronary heart surgery. The mechanisms that link loneliness and morbidity are unclear but one of the mechanisms may be through poor health beliefs and behaviours. The aims of this cross-sectional survey of 1289 adults were to investigate differences in health behaviours (smoking, overweight, BMI, sedentary, attitudes towards physical activity) in lonely and non-lonely groups. Lonely individuals were more likely to be smokers and more likely to be overweight–obese. The lonely group had higher body mass index scores controlling for age, annual income, gender, employment and marital status. Logistic regression revealed no differences in sedentary lifestyles. Lonely individuals were significantly less likely to believe it was desirable for them to lose weight by walking for recreation, leisure or transportation. The findings provide support for an association between health behaviours, loneliness and excess morbidity reported in previous studies.

Keywords: *Loneliness, obesity, physical activity, smoking, social isolation*

Introduction

The need for affiliation and engagement in rewarding social relationships is intrinsic to human beings and these affiliations have hormonal and neurophysiological substrates (Cacioppo et al., 2000, 2002a). Social relationships are essential for emotional and physical health and well-being (Hawkley & Cacioppo, 2003). Loneliness and social isolation are frequently used interchangeably, but although related are very different concepts. Loneliness can be conceptualized as the subjective perceived experience of social isolation (De Jong Gierveld & Kamphuis, 1985) and is thought to develop when the quality of relationships does not meet one's need for attachment (De Jong Gierveld, 1998). Social isolation is normally conceptualized in quantitative terms based on the number of social contacts one has access to at any given time.

There is now reasonably strong evidence that both loneliness and social isolation are associated with a range of adverse health outcomes. The health risk associated with loneliness has been less well studied than that of social isolation but may help bridge the abyss between

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the extant epidemiological and biological levels of analysis (Hawkley & Cacioppo, 2002). Uchino, Cacioppo, and Kiecolt-Glaser's (1996) meta-analysis suggests that it is loneliness, rather than social isolation, that is highly associated with the hormonal and autonomic changes. Perceived levels of social isolation may be more important than objective measurements and consequently it may be the quality not the quantity of social relationships that are important (Stokes, 1985). The perceived experience of social isolation formed the theoretical framework for loneliness the current study. It is a very common experience with reported prevalences of 35.7% in an Australian population (Lauder et al., 2004), and 32% in an elderly Netherlands population (van Tilburg & De Jong Gierveld, 1999).

Loneliness and morbidity

Social isolation and loneliness are both health-related risk factors that may be comparable to smoking, high blood pressure, obesity and lack of physical activity (House, Robbins, & Metzner, 1982). Social isolation is a significant predictor of mortality (Berkman et al., 2004). Cause-specific analysis in the Berkman et al., study found socially isolated men had an elevated risk of dying from cancer (relative risk = 3.60) and accidents – suicide (relative risk = 3.54). The expert working group of the National Heart Foundation of Australia report that there is strong evidence of an independent causal relationship between social isolation and coronary heart disease (CHD) (Bunker et al., 2003).

Loneliness is also linked to excess morbidity and mortality (Penninx et al., 1997) and is associated with a wide range of health problems, including heart disease (Heikkinen, Berg, Avlund, & Timo, 2002; Ort-Gomer, Unden, & Edwards, 1988) and depression (Alpass & Neville, 2003). Loneliness has consistently been associated with low subjective quality of life self-appraisals (Bramston, Pretty, & Chipuer, 2002) and poor self-rated health (Mullins, Smith, Colquitt, & Mushel, 1996). Patients who have just undergone coronary artery bypass graft surgery and who agreed with the statement "I feel lonely" had poorer survival rates at both 30-day and 5-year points (Herlitz et al., 1998). Chronically lonely people display more negative affectivity, are socially withdrawn, lack trust in others and are generally dissatisfied with their relationships (Ernst & Cacciopo, 1999).

The pre-disease pathways that link loneliness and excess morbidity are not fully understood but have been classified as health behaviours, attractiveness, stress, and repair and maintenance pathways (Hawkley & Cacioppo, 2003). Evidence in support of the latter is very limited, although lonely people have been shown to have poorer sleep efficiency, which may limit the restorative impact of sleep on health (Cacioppo et al., 2002b). The strongest evidence to date on pathways linking loneliness and morbidity relates to stress and repair biological mechanisms. Loneliness is a psychological experience with potentially adverse effects on biological stress mechanisms (Steptoe, Owen, Kunz-Ebrecht, & Brydon, 2004). Changes in the cardiovascular system have been observed in lonely people who have been shown to have higher peripheral resistance and lower cardiac output than non-lonely people (Cacioppo et al., 2002a). High loneliness groups also have poorer T-lymphocyte responses (Kiecolt-Glaser et al., 1984a) and potentially harmful changes in natural killer cell activity (Kiecolt-Glaser et al., 1984b; Benschop et al., 1998; Steptoe et al., 2004). Natural killer cells provide a non-specific immune response to a number of pathogens and may be implicated in some cancers and inflammatory responses in vascular disease.

Seeman, Singer, Ryff, Love, and Levy-Storms (2002) introduce the notion of allostatic load to describe cumulative biological risk over the lifetime of an individual as a consequence of loneliness. The allostatic notion is also supported by McEwen and Stellar (1993), who suggest that homeostasis fails to recognize the hidden toll of chronic stress. The

notion of allostasis highlights the cascading and cumulative nature of loneliness over time and the interrelationship between the social environment, how this is perceived and biological mechanisms, which include neural, neuroendrocrine and immune changes.

Evidence of a link between loneliness and social isolation, health behaviours and morbidity is somewhat contradictory. Health behaviours potentially implicated in a health behaviour pathway include smoking, obesity and lack of physical activity. Socially isolated men have been reported to be more likely to smoke (Berkman et al., 2004). As smoking is a major contributor to mortality and ill health, with over 19,000 deaths per year attributed directly to tobacco smoking in Australia (Australian Institute for Health & Welfare, 2003), the association between loneliness and smoking may provide a valuable insight into the behavioural health pathway that leads lonely people to poor health. Smoking and unemployment are the most important factors in explaining geographical variations in the rates of CHD and ischaemic heart disease mortality (Filate, Johansen, Kennedy, & Tu, 2003).

Many studies have shown that one of the two most frequently cited motives for physical activity participation is affiliation. Affiliation provides individuals with the opportunity to be with other people and belong to a group (Carron, Widmeyer, & Brawley, 1988; Estabrooks & Carron 2000). Furthermore, there is considerable support suggesting that social and group interaction along with the development of personal relationships play a significant and motivational role in increasing activity levels amongst adults (Estabrooks & Carron, 2000; Rejeski, Brawley, & Ettinger, 1997).

Hawkley, Burleson, Berntson, and Cacioppo (2003) and Steptoe et al. (2004) argue that health behaviours cannot explain excess morbidity and mortality. Epidemiological or laboratory research, it is argued, provides little support for a health behaviour pathway to excess morbidity and mortality (Hawkley et al., 2003). Steptoe et al. (2004) found no association between smoking and loneliness in middle-aged civil servants, although reported smoking rates were relatively low in this unrepresentative sample (9.7%). The General Household Survey 2001 (GHS, 2001) gives smoking prevalences in the general population of 28% for men and 26% for women. The evidence upon which a health behaviour pathway is rejected is based on studies of young university students, civil servants and elderly adults (Cacioppo et al., 2000, 2002a; Hawkley et al., 2003; Steptoe et al., 2004), and employed civil servants aged 47 – 59 years (Steptoe et al., 2004). These studies exclude vulnerable groups such as the unemployed and consequently cannot be generalized to the wider population. This is especially the case where health behaviours are concerned, given the clear link between income (Helmert, Mielck, & Shea, 1997), low-status jobs (Marmot et al., 1991), unemployment (Hammarstrom & Janlert, 2003) and poor health behaviours. A more inclusive study is required to investigate the associations between health behaviours and loneliness in an adult population, including those demographic groups excluded in previous studies

The aims of the current study were to investigate differences in health behaviours (smoking, weight, beliefs about activity, physical activity) in an adult population sample of lonely and non-lonely individuals. This survey was one element in the annual omnibus Central Queensland Social Survey (CQSS) conducted by the Population Research Laboratory at Central Queensland University. The study received ethical approval from the University Human Research Ethics Committee.

Methods

Cross-sectional self-report data were obtained from a random sample of 1278 adults by means of a computer-assisted-telephone-interview (CATI) survey in the central region of Queensland, Australia. The 2003 Central Queensland Social Survey was the fifth annual

omnibus survey conducted in the Central Queensland Region of Australia. A range of subject areas was included in the 2003 survey including sample demographics, the Active Australia survey and questions from the Social Capital Module of the General Household Survey. CATI methods can produce repeatable and efficient measurements of health (Anie, Jones, Hilton, & Anderson, 1996) and have been utilized in epidemiological research (Blyth et al., 2001; Lacchetti et al., 2001; Nickel et al., 1998).

Sampling

A two-stage stratified sampling design was used to select households and individuals randomly in Central Queensland. Calls were made to 2734 eligible households in regional Central Queensland in September 2003. The sample was drawn from the commercially available Electronic White Pages using a computer program to select, with replacement, a simple random sample of phone numbers. All duplicate, mobile and business numbers were purged from the computer-generated list. Nursing homes and collective dwellings were also deleted from the sample. Within each contacted household, one eligible person was selected (based on age, sex and availability) to act as the respondent for the interview.

In participating households, a single person was selected as the respondent for the 30-min interview. Selection was undertaken using the following selection guidelines to ensure an equal selection of male and female participants: (a) the dwelling unit must be the person's usual place of residence and he/she must be 18 years of age or older; (b) if an adult male answers the phone and is willing to be interviewed, he is the respondent; (c) if an adult female answers the phone and there is an adult male present who is willing to be interviewed, interview the male. If the male is not willing to be interviewed, and the female is willing, interview the female. (d) If an adult female answers the phone and there is no adult male present, choose her as the respondent. All respondents were 18 years of age or older at the time of the survey.

The survey estimates of sampling error for the total sample of 1,289 indicate that this is accurate within ± 2.7 percentage points, at a 95% *CI*. An overall response rate of 49.6% was achieved. The sample comprised of 1,289 participants with a mean age of 46.25 years ($SD = 15.61$) of whom 50.1% were female ($n = 645$) and 49.9% male ($n = 643$). The majority of participants were born in Australia ($n = 1135$, 89.8%) and a small number of Aboriginal ($n = 13$, 1%), Torres Strait Islander ($n = 1$, 0.1%) and Australians of South Sea Island origin ($n = 6$, 0.5%) were recruited.

Measures

The survey instrument included the Loneliness Scale, items from the Active Australia Survey, health belief questions and demographic questions on marital status, employment, age and gender. Marital status was classified as single, widowed, divorced, separated not divorced, married de facto (co-habiting). Marital status data were collapsed into married/partnered and not married/not partnered categories. Employed was defined as being in paid employment in the previous week. Age was recoded into <30, 30 – 39, 40 – 49, 50 – 59, 60+ categories (years).

Health beliefs and behaviours

Participants were asked whether they smoked and to estimate their height in centimetres and weight in kilograms. Body mass index (BMI) was calculated from self-report data on height and weight. The World Health Organisation classifies overweight and obesity on the

reported association between BMI and mortality (WHO, 2000). Participants were then classified as having a healthy weight (BMI 18.4 – 24.9) or overweight and obese (BMI $\geq$25.0). A question on attitude to taking physical activity for the purpose of losing weight was included. It is recognized that obesity is better seen as the consequence of behaviour rather than a health behaviour per se.

Physical activity items were derived from the Active Australia Survey (2003). This is designed to measure participation in leisure-time physical activity. It offers a short and reliable set of questions that can be easily implemented via CATI techniques. Self-reported physical activity data were collected and coded using the Active Australia Survey instrument, as recommended by the published guide for analysis and reporting (Active Australia Survey, 2003). Questions also included items on time spent in the last week walking to shops/work, walking for recreation, vigorous activity in the garden, vigorous activity exercising and moderate activity doing gentle exercise.

Australian Survey data were used to derive one dichotomous variable of sedentary behaviour that was used in further analyses. *Sedentary*—Respondents were classed as sedentary if they reported no time spent in walking, moderate, or vigorous intensity activities in the week prior to the survey. *Non-sedentary*—Respondents were classed as non-sedentary if they reported any time spent in walking, moderate or vigorous intensity activities in the week prior to the survey. A number of questions on attitudes towards undertaking moderate and vigorous physical activity for leisure and for weight loss were also included in the survey.

Loneliness

Loneliness was operationally defined by The Loneliness Scale (De Jong Gierveld & Kamphuis, 1985), which is an 11-item unidimensional scale, consisting of negative and positive items. The scale measures self-reported feelings of loneliness and was developed from the subjective perception of social isolation theory of loneliness. The reliability and validity of the scale has been established (de Jong Gierveld & van Tilburg, 1999). The scale provides scores ranging from 0 to 11, with scores of 3 and above being classified as lonely (De Jong Gierveld & Kamphuis, 1985). The dichotomous lonely variable (lonely or not lonely) was used in the study (De Jong Gierveld & Kamphuis, 1985). The reliability of the scale in the study reported here was satisfactory ($\alpha = .80$).

Data analysis

The questionnaire was pilot-tested by trained interviewers on a total of 15 randomly selected households. Interviewer comments (e.g., confusing wording, inadequate response categories, question order effect, etc.) and pre-test frequency distributions were reviewed and modifications were made to the questionnaire. The data cleaning process included wildcode, discrepant value and consistency checks.

Descriptive statistics were calculated for loneliness scores for the entire sample and by gender, marital status, employment status, smoking status and overweight/healthy weight groups. Bivariate analysis for differences in loneliness scale scores and gender, marital status, employment status, and age were explored using χ^2 tests. Mann – Whitney *U*-Tests were used to investigate ordinal attitudinal variables. Multivariate relationships were investigated using logistic regression analysis to explore the relationship between health behaviour variables and loneliness adjusting simultaneously for all other variables in the regression model. Logistic regression models for smoking, sedentary and overweight were performed. Variables in the regression models in addition to the dichotomous loneliness

variable were marital status, age, employment and gender. In smoking and sedentary regression analyses, overweight was included in the model. Crude and adjusted odds ratios (*OR*) with 95% confidence intervals (*CI*) are reported in all logistic regression models.

Findings

Demographics and loneliness

Most respondents were not lonely ($n = 827$, 65%) and 446 (35%) were classified as lonely. Loneliness was more common in males ($\chi^2 = 4.712$, $df = 1$, $p = .035$), unmarried/unpartnered ($\chi^2 = 22.227$, $df = 1$, $p = .001$) and unemployed participants ($\chi^2 = 8.083$, $df = 1$, $p = .004$).

BMI and overweight

The mean BMI of the not-lonely group was 26.26 ($SD = 5.19$) and 27.08 ($SD = 6.28$) in the lonely group. Analysis of covariance (ANCOVA) with gender, marital status, age, annual household income and employment as covariates revealed that the higher mean BMI in the lonely group was significant ($f = 6.873$, $df = 1$, $p = .009$). BMI data were then used to classify and describe the number of participants in each group who were above the healthy weight threshold of BMI $\geq$25. A higher proportion in the lonely group were overweight and obese ($n = 246$; 61.8%) than in the not lonely group ($n = 415$; 53.8%). The logistical regression analysis (Table I) indicates that lonely participants are more likely to be overweight and obese (adjusted *OR* 1.51, 95% *CI* 1.16–1.97).

In the Australia National Health Survey (ABS, 2002) 58% of all males and 42% of females were classified as overweight and obese. Coyne, Findlay, Ibiebele, and Firman (2004) suggest this data may under-report the true incidence of overweight and obesity in Australia

Table I. Crude and adjusted odds ratios for overweight/obese classification by demographic variables and loneliness.

	% Sample	% Overweight	Crude *OR*	Adjusted[a] *OR*[b]	95% *CI*
Gender					
Male	49.9	62.9	1.00	1.00	Reference
Female	50.1	49.7	0.58	0.62	0.48–0.79
Marital status					
Married	66.6	59.6	1.00	1.00	Reference
Not married	33.4	50.3	0.68	0.85	0.64–1.11
Employed					
No	38.5	54.9	1.00	1.00	Reference
Yes	61.5	57.5	1.11	1.41	1.06–1.89
Age group					
<30 years	16.1	37.2	1.00	1.00	Reference
30–39 years	19.0	54.9	2.05	2.06	1.36–3.12
40–49 years	22.4	59.3	2.46	2.31	1.54–3.45
50–59 years	21.1	62.0	2.78	2.70	1.78–4.08
60 years and older	21.3	64.3	3.04	3.45	2.21–5.37
Lonely					
No	35.0	53.8	1.00	1.00	Reference
Yes	65.0	61.8	1.38	1.51	1.16–1.97

[a]OR mutually adjusted for all other variables in the table.
[b]$n = 1163$.

and especially in the area in which the current survey was conducted, rural and regional Queensland. Lonely individuals reported being less likely to believe it was desirable for them to lose weight through walking for recreation, leisure or transportation purposes ($p = .049$; Table II).

Smoking

In the entire sample, 22.3% reported being smokers ($n = 282$). A higher proportion of smokers were found in the lonely group ($n = 128$; 28.8%) than were found in the not lonely group ($n = 154$; 18.6%). The logistic regression analysis (Table III) revealed an adjusted *OR* for smoking and loneliness of 1.55 (95% *CI* 1.14 – 2.09) having controlled for demographic variables and overweight and obesity.

Physical activity and beliefs

A total of 255 (20.1%) people were classed as sedentary; 157/825 non-lonely people were classed as sedentary (19.0%), whereas 97/443 lonely people were sedentary (21.9%).

Table II. Desirability to lose weight by walking.

	Not desirable	A little desirable	Somewhat desirable	Desirable	Extremely desirable
Lonely	138 (31.8%)	26 (6%)	40 (9.2%)	98 (22.6%)	132 (30/4%)
Not lonely	294 (36.4%)	71 (8.8%)	66 (8.2%)	155 (19.2%)	221 (27.4%)

Table III. Crude and adjusted odds ratios for smoking by demographic variables and loneliness.

	% Sample	% Smokers	Crude *OR*	Adjusted[a] *OR*[b]	95% *CI*
Gender					
Male	49.9	23.1	1.00	1.00	Reference
Female	50.1	21.1	0.91	0.85	0.63 – 1.14
Marital status					
Married	66.6	17.2	1.00	1.00	Reference
Not married	33.4	32.4	2.33	2.32	1.70 – 3.17
Employed					
No	38.5	18.4	1.00	1.00	Reference
Yes	61.5	24.5	1.44	0.99	0.70 – 1.40
Age group					
<30 years	16.1	27.3	1.00	1.00	Reference
30 – 39 years	19.0	31.3	1.21	1.59	1.01 – 2.52
40 – 49 years	22.4	24.7	0.87	1.27	0.80 – 2.00
50 – 59 years	21.1	21.9	0.74	1.10	0.68 – 1.77
60 years and older	21.3	8.4	0.24	0.32	0.18 – 0.59
Weight					
Acceptable weight	43.5	26.6	1.00	1.00	Reference
Overweight/obese	56.5	19.1	0.65	0.67	0.49 – 0.90
Lonely					
No	35.0	18.6	1.00	1.00	Reference
Yes	65.0	28.8	1.76	1.55	1.14 – 2.09

[a]OR mutually adjusted for all other variables in the table.
[b]$n = 1163$.

Logistic regression analysis (Table IV) revealed an adjusted *OR* for sedentary behaviour and loneliness of 1.21 (95% *CI* 0.88 – 1.51). Consequently variance in sedentary behaviours is associated with unemployment and age and is not associated with loneliness.

Lonely and non-lonely individuals were equally likely to believe that walking 30 min a day would improve their health ($p = .769$). Lonely individuals were less confident about their ability to walk for recreation, leisure or transportation for at least 30 min per day on most days of the week ($p = .004$; Table V).

Discussion

Cacioppo et al. (2002a) suggest that pre-disease pathways may be orthogonal, in that they exist independently of one another. This claim remains contentious as pre-disease pathways may interact in complex ways that we do not fully understand. The findings from this study provide support for an association between health behaviours and loneliness. The health behaviours of interest in this study were smoking, sedentary behaviour and overweight and obesity. No significant differences in sedentary behaviours were found. Data on beliefs

Table IV. Crude and adjusted odds ratios for sedentary by demographic variables and loneliness.

	% Sample	% Sedentary	Crude *OR*	Adjusted[a] *OR*[b]	95% *CI*
Gender					
Male	49.9	20.5	1.00	1.00	Reference
Female	50.1	19.6	0.94	1.08	0.80 – 1.45
Marital status					
Married	66.6	20.5	1.00	1.00	Reference
Not married	33.4	19.3	0.93	1.08	0.78 – 1.50
Employed					
No	38.5	19.7	1.00	1.00	Reference
Yes	61.5	20.3	1.04	1.44	1.01 – 2.07
Age group					
<30 years	16.1	12.8	1.00	1.00	Reference
30 – 39 years	19.0	19.4	1.64	1.80	1.03 – 3.13
40 – 49 years	22.4	15.8	1.27	1.21	0.68 – 2.13
50 – 59 years	21.1	26.5	2.45	2.40	1.39 – 4.12
60 years and older	21.3	24.2	2.17	2.83	1.59 – 5.03
Weight					
Acceptable weight	43.5	18.0	1.00	1.00	Reference
Overweight/obese	56.5	21.4	1.23	1.12	0.82 – 1.51
Lonely					
No	35.0	19.0	1.00	1.00	Reference
Yes	65.0	21.9	1.19	1.21	0.88 – 1.51

[a]OR mutually adjusted for all other variables in the table.
[b]$n = 1160$.

Table V. Confidence in ability to walk for recreation, leisure and transport.

	Not confident	Slightly confident	Somewhat confident	Confident	Completely confident
Lonely	42 (9.5%)	22 (5%)	23 (5.2%)	120 (27.3%)	233 (53%)
Not lonely	66 (8%)	26 (3.2%)	30 (3.7%)	196 (23.9%)	503 (61.3%)

about physical activity provided a somewhat inconsistent picture of the attitudes of lonely individuals towards physical activity. Although just as likely to be non-sedentary, lonely people were less confident in their ability to walk for 30 min every day. Confidence in ability to undertake physical activity at this level may not translate into non-participation, at least in this population.

Lonely people were more likely to smoke cigarettes than those who were classified as not lonely and allied to previous reports of higher fibrinogen levels in smokers this begins to raise some questions around the validity of the orthogonal model of pre-disease pathways. Current smokers have higher fibrinogen concentrations than non-smokers (Brunner et al., 1996). High fibrinogen is associated with an increased risk of CHD and stroke (Kofoed et al., 2003). This problem may be compounded by the finding that loneliness itself is associated with higher fibrinogen concentrations (Steptoe et al., 2004). The hypothesized smoking – fibrinogen – cardiac event link may be one example of a mechanism for excess cardiac events in lonely people in which health behaviours and biological pathways interact.

Lonely people had significantly higher mean BMI than non-lonely people. This difference was still apparent when controlling for gender, employment, marital status, age and annual income. Using the conventional BMI $\geq$25 cut-off point, more people in the lonely group were overweight.

There is some evidence linking loneliness with impaired self-regulation. Defining self-regulation as the ability to alter and maintain one's behaviour to confirm to socially defined standards, Baumeister, DeWall, Ciarocco, and Twenge (2005) showed experimentally that individuals who were socially excluded caused decreases in self-regulation. Given the social stigma that can be associated with being overweight and obese, and the general promotion of smoking as a socially unacceptable behaviour, it may be that lonely people are more disinclined to make the requisite effort to alter their condition than individuals who are not lonely, or not socially excluded. Certainly in the field of health behaviour and behaviour change the role of social support has been acknowledged as an important factor in health behaviour (Berkman & Glass, 2000). It may be that lonely people lack the normative support to adopt and adhere to health lifestyle choices.

Another example of what may be a single integrated pathway is the relationship between social circumstances, biological mechanisms and morbidity. Domestic violence is a predictor of loneliness (Lauder et al., 2004). Victims of domestic violence report high levels of stress (Bacchus, Mezey, & Bewley, 2003), have over a 50% increase in stress-related problems (Campbell et al., 2002) and stress accounts for 80% of the indirect effects of abuse on women's physical health (Sutherland, Bydee, & Sullivan, 2002). Stress (Kiecolt-Glaser et al., 1984a; Steptoe et al., 2004) and loneliness (Kiecolt-Glaser et al., 1984b) are linked to lower natural killer cell responses. Women who report poor-quality social relationships have elevated fibrinogen levels (Davis & Swan, 1999). Natural killer cell changes and heart rate responses to acute stress in women are regulated to some extent by the same mechanisms (Benschop et al., 1998). Natural killer cells are important regulators of immune responses and have been linked to the development of CHD (Ishihara, Makita, Imai, Hashimoto & Nohara, 2003; Weyand et al., 2001). This suggested socio-psychobiological pathway illustrates the potential complex interactions between social context, health behaviours, loneliness, biological mechanisms and morbidity.

The combination of increased smoking and higher rates of overweight – obesity represents an increase in the risk profile for those who are lonely. Developing and implementing tailored intervention programmes that provide practical knowledge regarding healthy lifestyle behaviour change, encourage social interaction and group development in

combination with a weight loss programme and physical activity programme may be a promising strategy to consider (Brawley, Rejeski, & Lutes, 2000; Cox, Burke, Gorely, Beilin, & Puddy, 2003). Evidence that loneliness, especially linked to specific diseases such as breast cancer, may be amenable to psychological interventions is beginning to emerge (Fukiu, Koike, Ooba, & Uchitomi, 2003). More general intervention strategies to tackle loneliness include raising awareness of social isolation and loneliness, challenging stigma and changing attitudes, improving and sharing good practice and joint agency initiatives designed to overcome practical barriers to social inclusion (Cattan & Ingold, 2003). The efficacy of this type of general intervention strategy remains to be demonstrated.

A number of limitations in the study design are evident, the first of which relates to CATI methods. CATI sampling may under-recruit younger unemployed participants and given the higher prevalence of poor health behaviour in this group rates of smoking and participation in physical activity may be underestimated. The use of self-reporting measures has a tendency to overestimate height and underestimate weight. Self-reporting is also subject to recall bias in estimating physical activity.

Conclusion

The differences in health behaviours reported in this study of a random sample of adults over 18 years, provides robust evidence in support of a health behaviour link between loneliness and excess morbidity reported in previous studies. It is suggested that pre-disease pathways may not be orthogonal but a complex interplay between the social, psychological and physiological mechanisms may link loneliness and disease. Intervention strategies should also be multi-dimensional and include a range of target behaviours from exercise and smoking cessation through to healthy eating. It appears that a principle mediating factor in adoption of, and adherence to, many health behaviours is some aspect of social support, social participation or social inclusion. Future intervention studies must examine the social context of the participants and examine approaches that will enhance successful behavioural change.

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