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Loneliness in psychotic illness and its association with cardiometabolic disorders

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ABSTRACT

Loneliness is an established risk factor for poor cardiometabolic health. People with psychotic disorders experience high rates of both cardiometabolic disease and loneliness, but how these factors are associated is poorly understood. Thus, using data from the second Australian National Survey of Psychosis we examined whether loneliness is associated with the likelihood of cardiometabolic disorder in psychotic illness. Loneliness was assessed using a single-item measure, with a 4-point scale (not lonely; lonely occasionally; some friends but lonely for company; socially isolated and lonely) whilst cardiometabolic status was assessed in terms of the criteria used to determine metabolic syndrome (elevated waist circumference, elevated triglycerides, reduced high-density lipoprotein cholesterol, elevated blood pressure, and elevated fasting glucose). Logistic regression was employed to examine whether loneliness was associated with metabolic syndrome status, and its individual components, with and without adjustment for confounding variables. Increased loneliness was associated with an increased risk of metabolic syndrome in people with psychosis (OR 1.21, 95% CI 1.08–1.36, $p < .001$) and to the risk of elevated waist circumference ($p < .01$), elevated triglycerides ($p < .05$) and reduced high-density lipoprotein cholesterol ($p < .05$). Notably, these associations largely persisted when controlling for a range of covariates. Feeling lonely is significantly associated with metabolic syndrome, and dyslipidemia specifically, in people with psychotic disorders. These data suggest that the potential benefits of interventions to reduce loneliness in psychosis may extend to cardiovascular as well as psychosocial functioning, and should be explored in future research.

1. Introduction

Loneliness is one of the major challenges in life for people with psychotic disorders (Michalska da Rocha et al., 2017; Morgan et al., 2017; Morgan et al., 2012) and is far more common in people with psychotic disorders than in the general community, regardless of diagnostic category or stage of illness (Badcock et al., 2015; Kudo et al., 2002; Michalska da Rocha et al., 2017; Sundermann et al., 2014). Those feeling lonely may, or may not, be lacking social relationships but what they do feel is a sense of social isolation and disconnection from others (Cacioppo and Cacioppo, 2014). Longitudinal and cross-sectional studies of the general population show that people who feel socially isolated and lonely are at increased risk both for physical morbidity and premature mortality, even when other risk factors and confounders have been accounted for (Cacioppo and Cacioppo, 2014; Caspi et al., 2006; Holt-Lunstad et al., 2015). Along with feeling lonely, the physical health of people with psychotic disorders is often poor and their life expectancy is reduced compared to the general population (Correll et al., 2017;

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Hjorthoj et al., 2017; Morgan et al., 2014; Reininghaus et al., 2015; Saha et al., 2007). Yet, the association between loneliness and physical health in psychosis has so far received scant empirical investigation (Tremeau et al., 2016).

Loneliness is a potent biopsychosocial stressor (Cacioppo et al., 2015) associated with adverse changes in cardiovascular function, cortisol levels, neuroendocrine response and anti-inflammatory signaling pathways (Hackett et al., 2012; Hawkley and Cacioppo, 2010; Hawkley and Capitanio, 2015; Holt-Lunstad and Smith, 2016; Leigh-Hunt et al., 2017). For example, loneliness has been consistently associated with increased activation of the hypothalamic-pituitary-adrenocortical axis – the major stress-regulation system – as well as increased vascular resistance and lower cardiac output (Hawkley et al., 2010). Systematic reviews, drawing on both longitudinal and cross-sectional data, have shown that loneliness is associated with a range of physical illnesses including: heart disease, hypertension, stroke, obesity and diabetes (Petitte et al., 2015; Valtorta et al., 2016).

Previous research suggests that the cardiometabolic disease, defined in terms of the metabolic syndrome, offers a pathway by which loneliness increases the risk for adverse health outcomes (Whisman, 2010). Metabolic syndrome refers to a cluster of inter-related factors (central obesity, dyslipidaemia, elevated blood pressure and elevated fasting glucose) that is highly predictive of cardiovascular disease, diabetes and death (Alberti et al., 2009; Gami et al., 2007). Using a population-based sample, Whisman (2010) showed that, controlling for sociodemographic variables and health risk behaviours, loneliness in the general population was significantly associated with an increased risk of metabolic syndrome. Importantly, people with psychotic disorders have increased rates of metabolic syndrome and all its components (Foley et al., 2013; Gardner-Sood et al., 2015; Morgan et al., 2014; Vancampfort et al., 2015). As a consequence, modifiable risk factors for metabolic syndrome are now considered a key target for intervention (Hahn et al., 2016; Morgan et al., 2017; Suetani et al., 2016). Despite the potential significance of this issue, little is known about the relationship between metabolic syndrome and loneliness in psychotic illness. The only relevant study to date showed that loneliness in patients with schizophrenia or schizoaffective disorder predicted a comorbid diagnosis of hypertension, but not of dyslipidemia or obesity (Tremeau et al., 2016). However, a small sample size limited the power of the study to detect group differences. Nor did it explore the relationship between loneliness and metabolic syndrome.

In the current study, we examined the association of loneliness with cardiometabolic disorder defined in relation to the metabolic syndrome and its individual components in a large sample of people with a psychotic illness.

2. Methods

2.1. Study population

Data from 1825 participants with psychosis were drawn from the second Australian National Survey of Psychosis - the Survey of High Impact Psychosis (SHIP). The SHIP was designed to estimate the treated prevalence of psychosis in adults (18–64 years) in contact with public mental health services, and to describe their mental and physical health, cognitive functioning, substance use, and personal and social circumstances. Full details of the population coverage, design and methods employed in the SHIP have been described elsewhere (Morgan et al., 2014; Morgan et al., 2012).

2.2. Key assessments

2.2.1. Diagnostic classification

Symptom evaluation was undertaken with the Diagnostic Interview for Psychosis (DIP; Castle et al., 2006). In the present study, the symptoms reported as present in the past 12 months were used. Diagnostic classification was made by a computer algorithm, which maps DIP items onto the Operational Criteria (OPCRIT; McGuffin et al., 1991) checklist and generates diagnoses in accordance with ICD-10. This approach reduced subjective bias in the interpretation of symptoms, and inter-rater reliability has previously been shown to be good (see Morgan et al., 2014). Participants who screened positive for psychosis but did not meet full criteria for an ICD-10 psychotic disorder (schizophrenia, schizoaffective disorder, bipolar disorder with psychotic features, depressive psychosis and delusional disorder) were excluded from the current analyses (N = 183).

2.2.2. Assessment of loneliness

Consistent with our previous work (Badcock et al., 2015), classification of loneliness was based on responses to the following item, adapted from Australian Quality of Life Survey (Hawthorne et al., 1999) - "In the last 12 months have you felt lonely?" Responses were made using a 4-point scale, ranging from not feeling lonely to definite loneliness: (1) I have plenty of friends and have not been lonely; 2) Although I have friends I have been lonely occasionally; 3) I have some friends but have been lonely for company; 4) I have felt socially isolated and lonely). A total of 45 participants failed to respond to this question and so were excluded from further analyses.

2.2.3. Physical health assessment

Blood pressure, height, weight and waist circumference measurements were taken by trained staff using standardized procedures and identical equipment (details in Morgan et al., 2014 online Supplementary Methods). Fasting venous blood samples were drawn for standard assays of plasma glucose, triglycerides, high-density lipoprotein cholesterol and total cholesterol concentrations, using accredited pathology laboratories. Harmonized IDF criteria were used to determine the metabolic syndrome (Alberti et al., 2009), defined as meeting three or more of the following five criteria: (1) elevated waist circumference (cm) (population and country specific cut points ≥90 or 94 cm for men and ≥80 cm for women); (2) elevated triglycerides (≥150 mg/dL [1.7 mmol/L]); (3) reduced high-density lipoprotein (HDL) cholesterol (<40 mg/dL [1.0 mmol/L] for men, <50 mg/dL [1.3 mmol/L] for women); (4) elevated systolic or diastolic blood pressure (≥130 mm/Hg; ≥85 mm/Hg); and (5) elevated fasting glucose (≥100 mg/d [5.6 mmol/L]). A criterion was regarded as met if the person was receiving antihypertensive, antiglycaemic or lipid regulating medication. A total of 474 participants had no, or insufficient, metabolic measurements and so were excluded from the present study.

2.2.4. Additional measures

Participants provided detailed information about their illness history, social and personal circumstances, including school completion, current employment, marital status and indigenous status (Aboriginal and Torres Strait Islander, ATSI). Course of illness was ascertained as a single episode with good recovery; multiple episodes with good recovery between; multiple episodes with partial recovery between; continuous chronic illness; or, continuous chronic illness with deterioration. Participants were classified as having a good lifetime illness trajectory (single or multiple episodes with good recovery) or poor lifetime illness trajectory (multiple episodes with partial recovery, continuous chronic illness with/without deterioration). Socio-economic status was based on postcode of residence at time of interview using the Index of Relative Socio-Economic Disadvantage derived by the Australian Bureau of Statistics (2008). Deciles were constructed, with the first decile representing the most disadvantaged postcodes and the tenth decile the least disadvantaged. Lifestyle information was collected, including level of physical activity in the seven days prior to interview, using the International Physical Activity Questionnaire short form (Craig et al., 2003). Activity was categorized into three levels (low, moderate or high) using scoring guidelines (Waterreus et al., 2016). The Alcohol Use Disorders Identification Test was also administered, and the

AUDIT-C score was used to create a binary variable indicating hazardous drinking in the previous 12 months (Bush et al., 1998); a score of three or more for women and four or more for men on the AUDIT-C indicated hazardous drinking. Participants were classified as current smokers if they had smoked tobacco in the previous four weeks. All prescribed medication taken for at least the previous four weeks was recorded (Waterreus et al., 2012). Finally, the Digit Symbol Coding Test (DSCT) from the Repeatable Battery for the Assessment of Neuropsychological Status (Randolph et al., 1998) provided a brief but reliable index of current cognitive ability. Since raw DSCT scores vary with age, we classified participants' scores as 'impaired' (>1 SD below) or 'intact' (within 1 SD or above) based on age-stratified Australian population means (Australian Schizophrenia Research Bank, 2011).

2.3. Ethics approval

The study was approved by institutional human research ethics committees at each of the seven study sites and all participants provided written informed consent.

2.4. Data analysis

Data analysis was conducted using SPSS (IBM, 2013), version 21.0. Only individuals who provided a fasting blood sample and who met ICD-10 criteria for a diagnosis of psychosis (N = 1156 out of 1825 SHIP participants) were included in the current analyses. 'Raw,' unadjusted odds ratios for the presence or absence of metabolic syndrome and each of the five factors defining metabolic syndrome, given loneliness status, were estimated in logistic models. Linear effects of the loneliness variable are reported; non-linear (i.e. categorical) effects were initially explored but no substantial deviations from linearity were found. The association of loneliness with the metabolic syndrome status and each of its components was then evaluated after adjustment for each of a range of individual potential confounding factors (including sociodemographic, lifestyle and clinical variables). Factors that were significantly associated with the syndrome, or any of its components, were identified and included in multiple predictor models. Preliminary analyses confirmed the linearity of effects of age and SIEFA scores. Initial analyses of DSCT performance categories included a 'not available' category which was found not to differ from participants who scored no more than one standard deviation below the population mean: accordingly, these classifications were combined. Lastly, similar effects were attributable to low and medium levels of activity so these groups were aggregated in the adjusted analyses.

3. Results

3.1. Sample characteristics

The final data set comprised 1156 individuals. The metabolic, loneliness, clinical and sociodemographic characteristics of this sample are summarized in Table 1. Participants ranged in age from 18 to 64 years and were predominantly male, single and not in paid employment. The most common diagnostic category was schizophrenia, and more than three quarters were receiving atypical antipsychotics. A majority of participants indicated that in the previous twelve months they had experienced feeling lonely occasionally, lacked company, or felt socially isolated. Over half (57%) met harmonized criteria for the metabolic syndrome. The percentage of participants meeting thresholds for the individual components of metabolic syndrome were: increased waist circumference 83.8%; elevated triglycerides, 53.8%; reduced HDL cholesterol 52.5%; elevated blood pressure, 56.2%; and elevated fasting glucose, 31.1%.

Table 1
Metabolic syndrome status, loneliness, and characteristics of people with psychosis aged 18–64 years.

Characteristic	n[a]	% or M(SD)
Metabolic syndrome components and threshold criteria		
Metabolic syndrome		
Met criteria – no	495	43.1%
Met criteria – yes	653	56.9%
Waist circumference (cm)		
Met criteria – no	184	84.59 (7.0)
Met criteria – yes	949	111.40 (17.2)
Triglycerides (mmol/L)		
Met criteria – no	548	1.08 (0.3)
Met criteria – yes	606	2.86 (1.5)
HDL cholesterol (mmol/L)		
Met criteria – no	502	1.41 (0.4)
Met criteria – yes	643	0.98 (0.3)
Blood pressure (mm/Hg)		
Met criteria – systolic no	525	112.24 (9.9)
Met criteria – systolic yes	608	132.29 (15.3)
Met criteria – diastolic no	525	74.18 (7.0)
Met criteria – diastolic yes	608	90.25 (9.9)
Fasting glucose (mmolL)		
Met criteria – no	794	4.89 (0.4)
Met criteria – yes	359	6.62 (1.4)
Loneliness		
I have plenty of friends and have not been lonely	228	20.1%
Although I have friends I have been lonely occasionally	357	31.5%
I have some friends but have been lonely for company	293	25.9%
I have felt socially isolated and lonely	255	22.5%
Sociodemographic attributes		
Sex		
Male	712	61.6%
Female	444	38.4%
Age (years)		38.4 (11.0)
Marital status		
Currently married or de facto	205	17.7%
Currently single, separated, divorced or widowed	951	82.3%
Education		
Completed year 12	364	31.7%
Completed less than year 12	783	68.3%
Employment		
In paid work (last 12 months)	370	32.0%
No paid work (last 12 months)	786	68.0%
Indigenous identity		
Aboriginal or Torres Strait Islander	59	5.1%
Non-indigenous	1097	94.9%
Socioeconomic disadvantage SEIFA deciles		
1 (greatest socioeconomic disadvantage)	195	16.9%
2	65	5.6%
3	165	14.3%
4	106	9.2%
5	184	15.9%
6	135	11.7%
7	74	6.4%
8	107	9.3%
9	43	3.7%
10 (least socioeconomic disadvantage)	80	6.9%
Clinical characteristics		
Current cognitive functioning (DSCT)		
Intact (within 1 SD or above norms)	200	17.3%
Impaired (>1SD below norms)	855	74.0%
DSCT score not available	101	8.7%
ICD-10 diagnoses		
Schizophrenia	591	51.1%
Schizo-affective disorder	211	18.3%
Bipolar disorder with psychotic features	225	19.5%
Psychotic depression	63	5.4%
Delusional disorders & non-organic psychosis	66	5.7%
Medication used (past 4 weeks)		
Typical antipsychotics	183	15.8%
Atypical antipsychotic	905	78.3%
Mood stabilisers	352	30.4%
Antidepressants	436	37.7%
Anxiolytics	195	16.9%
No medications	63	5.4%
Course of illness		
Single or multiple episode with good recovery	422	36.5%

Table 1 (*continued*)

Characteristic	n[a]	% or M(SD)
Partial recovery or chronic illness	734	63.5%
Lifestyle variables		
Smoking status		
Current smoker	750	65.4%
Not current smoker	397	34.6%
Alcohol consumption		
Hazardous drinking	513	44.7%
No or non-hazardous drinking	634	55.3%
Physical activity level		
Low	558	48.9%
Moderate	418	36.6%
High	166	14.5%

[a] Totals range from 1133 to 1156 due to missing information for some variables.

3.2. Association between loneliness and metabolic syndrome

Table 2 shows the unadjusted odds ratio of meeting criteria for metabolic syndrome and each of its components as a function of loneliness, as well as the odds ratio adjusted for the identified confounding factors. The results clearly show that there is no attenuation of the association between loneliness and metabolic syndrome, or three of its components (increased waist circumference, elevated triglycerides and reduced HDL cholesterol), following adjustment for this broad range of variables. Additional analyses were undertaken to explore possible non-linear effects of loneliness and interactions of loneliness with each of the factors: no significant interactions were found and deviations from linearity were negligible.

Of note, the corrected odds for the presence of metabolic syndrome increased 1.2 times for each unit change in loneliness. Additional odds ratios comparing categorical response options 1) 'I have plenty of friends and have not been lonely' and 4) 'I have felt socially isolated and lonely' (a three point difference in scale responses) were somewhat larger (OR: 1.72 95% CI: 1.52–1.95) – but significance was unchanged (data available on request). A similar pattern was observed with odds ratios for waist circumference (OR: 1.83 95% CI: 1.55–2.16), elevated triglycerides (OR: 1.44–95% CI: 1.28–1.63) and lowered HDL cholesterol (OR: 1.44 95% CI: 1.28–1.62).

4. Discussion

4.1. Main findings

We examined the association between loneliness and cardiometabolic disorder in people with a psychotic illness, using extant data collected in the second Australian National Survey of Psychosis. We found a significant, linear relationship between increased loneliness and the likelihood of meeting the criteria for metabolic syndrome in people with a psychotic disorder. Specific associations were also observed between loneliness and increased waist circumference, elevated levels of triglycerides and reduced HDL cholesterol, together reflecting the degree of insulin resistance - the basis of the metabolic syndrome (Levine and Levine, 2006). Furthermore, these results appear to be relatively robust, since adjusting for a wide range of confounding factors linked to poor cardiovascular health (such as age, sex, marital status, lack of employment; alcohol use, smoking and physical activity levels; course of illness and medication used) had almost no effect on the strength or statistical significance of this association. The only difference observed was that, following adjustment for these factors, the association with elevated triglycerides was found to be marginally non-significant ($p = .07$). These findings are in keeping with a larger body of evidence from the social neurosciences linking loneliness with poor physical health and metabolic functioning (Cacioppo and Cacioppo, 2014; Whisman, 2010). They also serve as a useful reminder that mental and physical health are closely entwined and may need to be considered together more often in treatment planning for people with psychotic disorders.

Whilst the current evidence supports the idea that cardiometabolic health is significantly related to loneliness in people with psychotic disorders, the directionality of this association is unclear, and bidirectional effects are plausible. It is possible, for example, that high triglycerides/low HDL cholesterol and increased waist size may be casually related to loneliness via a common antecedent. Being overweight, for instance, is socially stigmatized (Papadopoulos and Brennan, 2015) and has previously been associated with Social Withdrawal Syndrome, which is characterized by low trust beliefs, low disclosure to close others and high levels of loneliness (Rotenberg et al., 2017). Conversely, it is possible that loneliness plays a causal role in the development of the

Table 2
Logistic regression analysis predicting metabolic syndrome and its component criteria in adults with psychosis. Unadjusted and adjusted odds ratio (ORs) for loneliness, and adjusted ORs for potential confounding factors.

Predictor (reference category)	Metabolic syndrome		Metabolic syndrome component criteria									
			Increased waist circumference		Elevated Triglycerides		Reduced high density lipoprotein cholesterol		Elevated blood pressure		Elevated fasting glucose	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Loneliness (unadjusted)	1.21***	1.08–1.36	1.25**	1.07–1.46	1.15*	1.03–1.29	1.15*	1.03–1.29	1.08	0.97–1.21	1.03	0.91–1.16
Loneliness (adjusted)	1.19**	1.05–1.35	1.22*	1.03–1.45	1.12	0.99–1.26	1.13*	1.01–1.28	1.09	0.97–1.23	1.02	0.90–1.16
Sex (female)	1.02	0.77–1.34	0.22***	0.14–0.36	1.36*	1.04–1.77	0.82	0.63–1.07	1.40*	1.07–1.83	1.24	0.94–1.65
Age (years)	1.04***	1.03–1.05	1.03***	1.02–1.05	1.03***	1.02–1.04	1.00	0.99–1.01	1.04***	1.03–1.06	1.04***	1.03–1.06
Marital status (married/de facto)	1.06	0.75–1.49	1.49	0.92–2.40	1.18	0.84–1.65	0.99	0.71–1.37	0.87	0.62–1.21	1.46*	1.01–2.12
Education (finished year 12)	1.03	0.77–1.37	1.16	0.78–1.72	0.95	0.72–1.27	1.14	0.86–1.51	1.10	0.83–1.46	1.21	0.89–1.63
Employment (employed)	1.36*	1.02–1.82	1.04	0.70–1.53	1.35***	1.01–1.79	1.22	0.92–1.62	1.42*	1.07–1.88	1.16	0.85–1.58
Indigenous identity (not indigenous)	1.18	0.65–2.15	0.56	0.27–1.15	0.93	0.52–1.67	0.92	0.52–1.62	1.31	0.74–2.31	1.48	0.83–2.66
Socioeconomic disadvantage SEIFA (decile)	0.99	0.94–1.04	0.93*	0.87–0.99	0.99	0.94–1.04	0.98	0.94–1.03	1.00	0.95–1.05	1.01	0.96–1.06
Current cognitive functioning (DSCT)	1.93***	1.43–2.61	1.30	0.86–1.96	1.65	1.23–2.22	1.52**	1.14–2.03	1.13	0.85–1.52	1.39	1.01–1.91
Current smoker (non-smoker)	1.33	0.99–1.77	0.60*	0.39–0.93	1.36*	1.02–1.80	1.68***	1.27–2.23	0.85	0.64–1.13	1.26	0.93–1.71
Alcohol consumption (not at risk status)	1.32*	1.01–1.73	1.05	0.73–1.51	1.23	0.95–1.61	1.59***	1.22–2.07	0.79	0.61–1.04	1.09	0.82–1.44
Physical activity (not highly active)	1.68**	1.15–2.46	1.63*	1.04–2.56	1.42	0.97–2.07	1.44*	1.00–2.07	1.11	0.77–1.61	0.98	0.66–1.47
Medication used in past 4 weeks (none)	2.96***	1.57–5.61	2.67**	1.40–5.08	2.48**	1.32–4.66	2.29**	1.28–4.09	0.98	0.56–1.72	1.63	0.81–3.26
Course of illness (good recovery)	1.14	0.87–1.50	1.01	0.70–1.46	1.47**	1.13–1.91	0.91	0.70–1.19	0.97	0.75–1.27	1.17	0.88–1.56

Notes: OR = odds ratio; 95% CI = 95% confidence interval. Age and SEIFA score are continuous, scaled predictors.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

metabolic syndrome. Drawing on longitudinal studies in humans and experimental evidence on animals, Cacioppo and colleagues have argued that loneliness is a potent social stressor that leads, inter alia to an increased morning rise in cortisol and decreased glucocorticoid receptor sensitivity, indicating increased activity in the hypothalamic-pituitary-adrenocortical axis (Cacioppo et al., 2015). Together, these processes may increase the risk of lonely individuals (with or without psychotic illness) developing the metabolic syndrome (Valtorta et al., 2016). If this causal pathway is correct, then psychosocial interventions to remediate loneliness (Masi et al., 2011) could potentially lead to improvements in the cardiovascular health of people with psychosis and merit further investigation. In particular, longitudinal studies are needed to help unravel the pathways linking loneliness and the metabolic syndrome.

Of the additional factors assessed, medication used in the last four weeks was the highest predictor of metabolic syndrome (OR = 2.96), with significant associations for three of the specific criteria, namely, increased waist circumference, elevated triglycerides and reduced high density lipoprotein, but not with elevated blood pressure or elevated fasting glucose. Adverse metabolic changes associated with antipsychotic use has been well described in the literature (Elias and Hofflich, 2008; Rojo et al., 2015) and support the need for continued monitoring of measures, and preventative care for metabolic syndrome in routine clinical practice (Mitchell et al., 2012).

4.2. Strengths and limitations

There are a number of limitations in the current study. First, not all participants provided fasting blood samples; whilst over 70% did so, it is possible that those who did not were not a random sample which may have introduced a source of bias. Second, loneliness was assessed with only a single-item measure which may have limited reliability compared to multi-item tools. Partly countering this concern, a recent meta-analysis by Michalska da Rocha et al. (2017) showed that single-item measures yield a similar degree of association between loneliness and psychosis to more comprehensive measures of loneliness. Due to the relatively small sample sizes in some diagnostic categories the current analyses pooled data across five different types of psychotic disorder; consequently differential relationships between loneliness and metabolic syndrome across diagnostic categories may have been missed. Conversely, the study had a number of strengths including: the use of trained diagnostic interviewers; well-validated measures of metabolic syndrome; a broad range of clinical, demographic and lifestyle variables as potential confounding factors in the analysis; and a large, representative sample of patients with psychosis in contact with public treatment services.

4.3. Conclusions

The current findings suggest that loneliness in psychotic disorders is associated with poor physical health. Combined with earlier evidence linking loneliness to poor mental health in many of these patients (i.e. impairments in current cognitive functioning) (Badcock et al., 2015) our findings lend further support for targeted interventions to reduce loneliness in this population. Future studies should explore whether reducing levels of loneliness also results in an improvement in metabolic functioning in people with psychosis and, if so, determine more precisely how this happens.

Conflict of interest

All authors confirm that there are no conflicts of interest to declare.

Contributors

JCB developed the idea for the study and plan of analysis, and wrote the manuscript. AM conducted the statistical analyses, with input from AW and VM. All authors assisted in revising the manuscript and approved the final version for submission.

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The Australian Government Department of Health and Ageing had no input into the design, analysis or interpretation of the current study.

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