

**Longitudinal Association between Loneliness and Metabolic Syndrome**

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### **Abstract**

Loneliness is associated with a variety of mental and physical health outcomes leading to a multitude of studies being conducted in the past to identify the pathway by which loneliness leads to poorer physical health. The current study was conducted using a large probability sample of English adults to investigate the longitudinal association between loneliness and metabolic syndrome, which refers to a group of conditions that can lead to diabetes, stroke, and other health conditions. Several studies have found significant cross-sectional associations between loneliness and metabolic syndrome, and the current study builds on prior research by examining the degree to which loneliness predicts the 4-year incidence of metabolic syndrome and the individual components of metabolic syndrome – central obesity, raised triglycerides, reduced HDL cholesterol, raised blood pressure, or raised fasting plasma glucose – using data from Wave 2 and Wave 4 of the English Longitudinal Study of Ageing ( $N = 1,094$ ). Results from logistic regression analyses indicated that loneliness was not significantly associated with incidence of metabolic syndrome or any of its individual components. Furthermore, the longitudinal association between loneliness and metabolic syndrome or its components was not moderated by gender or age.

### **Longitudinal Association between Loneliness and Metabolic Syndrome**

As many people discovered during the COVID-19 pandemic lockdown, the experience of loneliness can severely affect one's mental health. A number of people found themselves struggling with sudden loneliness, often turning to therapists, pharmacologists, bread baking, and other methods to help get through the lockdowns. However, loneliness is a pervasive issue that can be found regardless of the circumstances and can even be chronic (Rico-Urbe et.al., 2018). Although there are several possible definitions of loneliness, one definition is the discrepancy between the interpersonal relationships a person perceives they have compared to the ones they desire (Bahr et.al., 1982). Studies have been conducted to estimate the prevalence of loneliness, with one study indicating that at least one in four adults in developed countries are lonely (Chawla et.al., 2021). Loneliness does not only have an influence on mental health but on physical health as well. The aim of the current study was to examine the longitudinal association between loneliness and one indicator of health: metabolic syndrome.

Although there are several definitions of metabolic syndrome, it is generally defined in terms of the five following components: central obesity, raised triglycerides, reduced HDL cholesterol, raised blood pressure, or raised fasting plasma glucose (International Diabetes Federation, 2006). Metabolic syndrome an important biomarker of health because prior research into metabolic syndrome has indicated that it leads to an increased risk of serious health problems such as cardiovascular issues, stroke, diabetes (Saklayen, 2018), and mortality (Henriksen et. al 2019). The likelihood of developing metabolic syndrome increases with age and is likely to become the main risk factor for developing cardiovascular disease (Johns Hopkins, 2021). Because metabolic syndrome is predictive of a variety of health outcomes and

that the risks that developing metabolic syndrome pose to the population are quite high, research conducted to identify potential risk factors for developing metabolic syndrome is important.

### **Loneliness and Health**

Loneliness has been shown to potentially affect physical health in a variety of ways. For example, loneliness has been shown to potentially influence cardiac health, sleeping habits, and even diet. In a study by Matthews and colleagues (2017), the relationship between loneliness and sleep quality in young adults was investigated. Data were collected from over 2,000 twins in England and Wales and the researchers found a strong correlation between loneliness and sleep quality indicating loneliness may have a large influence on our physical health. Another study by Cacioppo and colleagues (2002) found a relationship between loneliness and several health factors in participants 25 years and older. Results revealed that cardiac contractility, heart rate, and cardiac output were all greater in non-lonely participants relative to lonely patients when those who scored in the top 15% of the sample (i.e., the loneliest participants) were compared with those who scored in the bottom 15% of the sample (i.e., the least lonely participants). Furthermore, similar to the Matthews and colleagues (2017) study, it was reported that lonelier individuals experienced lower quality of sleep.

Not only may loneliness influence our physical health, but results from several studies suggest that it may also have a substantial effect on our health behaviors and how we manage our physical health. A study by Sarkadi and Rosenqvist (2001) investigated how people diagnosed with type 2 diabetes managed their condition. The study was conducted on 105 participants during a 12-month education program and data were collected on demographic variables to see if they were predictors for glycemic control. Results showed a negative correlation between scores on the loneliness measures and diabetes control. This is important because it shows that

loneliness may have substantial effects not only on our health itself but on the ways we manage our physical health, therefore leading to less favorable health outcomes.

### **Loneliness and Components of Metabolic Syndrome**

Support for the current focus on loneliness and metabolic syndrome comes from research suggesting the loneliness is associated with the specific biological markers used to define metabolic syndrome. Firstly, researchers have studied the association between loneliness and central obesity. Obesity itself has increased substantially in the past 30 years globally, and interventions designed to address this increase have been unsuccessful for the most part (Dixon, 2010). Obesity is associated with a variety of physical and mental health outcomes. For example, prior research suggests that obesity may play a role in cardiovascular disease, type-2 diabetes, some cancers, osteoarthritis, and ultimately plays a role in earlier mortality (Dixon, 2010). A meta-analysis conducted by Petite and colleagues (2015) found that the studies on loneliness and obesity often stated loneliness led to obesity but there were mediating factors to the relationship. For example, one study stated that loneliness led to poor sleep quality which ultimately led to obesity (Stessman et. al., 2006). Another study mentioned in the meta-analysis was conducted by Morse and colleagues (2006) on 714 participants regarding nighttime eating behaviors. The researchers found that of the 40.2% of the participants who reported loneliness, 63.8% reported night-eating symptoms and when compared to those without night-eating symptoms, those who exhibited night-eating symptoms were more likely to be obese. The researchers suggested that the emotion of loneliness is associated with the behavior of night-eating which is associated with obesity.

Secondly, there is research suggesting a relationship between loneliness and raised blood pressure. Blood pressure is the pressure at which the blood pumped through our body is putting

on our arteries (American Heart Association, 2017). Otherwise known as hypertension, high blood pressure contributes to a variety of health issues, including stroke, angina, heart attack, heart failure, kidney failure, peripheral arterial disease, and early mortality (American Heart Association, 2017). Hawkley and colleagues (2010) found that there was both a cross-sectional and longitudinal positive association between loneliness and blood pressure in middle-aged and older adult men. The research was conducted over a 5-year period on men ages 50-68 years old in Chicago. Loneliness was measured at onset and the blood pressure of the participants was measured annually. The researchers found that the systolic blood pressure increased significantly in lonely participants after 2, 3, and 4 years compared to less lonely participants. The researchers stated that this relationship was independent of age, gender, and ethnicity among other factors.

To date, there is no published research on the potential relationship between loneliness and raised fasting plasma glucose. A raised plasma glucose level means your body is not processing sugar as rapidly as it should be, which is a sign of the beginnings of insulin resistance which is what leads to diabetes. Having impaired fasting glucose puts a person at higher risk of developing type 2 diabetes and cardiovascular disease (Johns Hopkins, N/D).

To date, there is also no published research on the potential relationship between loneliness and raised triglycerides. Triglycerides are a type of fat in the blood from the food we eat and when the body needs energy it will release triglycerides (Cleveland Clinic, N/D). Raised triglycerides can raise a person's risk for various serious heart diseases.

Finally, there has been some research examining the relationship between loneliness and reduced levels of HDL (High-Density Lipoprotein) cholesterol. HDL cholesterol is the “good” cholesterol that absorbs the cholesterol in the body and carries it to the liver where it is flushed

from the body (CDC, N/D). Higher levels of HDL reduce the risk for heart disease and stroke. Previous research by Shankar and colleagues (2011) found that there was no significant association between levels of social isolation and loneliness and HDL levels or total HDL. The researchers used the English Longitudinal Study of Aging (ELSA) to examine the impact of loneliness and social isolation on health behavior and biological factors in a cross-sectional analysis. There were several factors included in the study that were influenced by loneliness and isolation, HDL levels were found to not be significantly influenced by loneliness in the 5,899 participants included in the lipids analysis.

### **Loneliness and Other Risk Factors for Metabolic Syndrome**

Support for the current focus on loneliness and metabolic syndrome comes from research suggesting that loneliness is associated with other risk factors associated with metabolic syndrome. For example, one of the risk factors for developing metabolic syndrome is stress (Johns Hopkins, 2021). A meta-analysis conducted by Brown and colleagues (2018) on the relationship between loneliness and acute stress reactivity in eleven studies suggest that in the majority of the studies, higher levels of loneliness were predictive of exaggerated physiological reactions to stress. Higher levels of loneliness were also associated with increased blood pressure in their study, which is a component of metabolic syndrome. Similarly, a study conducted by DeBerard and colleagues (1995) found that intensity and duration of loneliness was significantly and positively correlated with reported psychological and somatic stress symptoms.

Other studies indicate that loneliness can have an impact on other risk factors for metabolic syndrome as well. Alcohol use is another risk factor for metabolic syndrome (Johns Hopkins, 2021) and a meta-analysis of studies published over the course of 40 years found that

loneliness may be a contributing and maintaining factor of alcoholism (Åkerlind & Hörnquist, 1992).

Another risk factor for developing metabolic syndrome is weight gain which has been studied in conjunction with loneliness. A study by Jaremka and colleagues (2015) found that women with lower body mass index (BMI) who had higher levels of loneliness had a greater ghrelin increase following a meal. Ghrelin is the hunger hormone so the increased levels of the hunger hormone therefore could cause greater food intake and could ultimately lead to potential weight gain. Similarly, research gathered in a series of four experiments conducted by Saine and Zhao (2021) revealed that loneliness can give rise to unhealthy food consumption, which can contribute to obesity. Therefore, the greater chance of experiencing obesity due to loneliness could directly impact the likelihood of experiencing metabolic syndrome.

In summary, loneliness has been associated with engaging in or experiencing several risk factors for metabolic syndrome. Therefore, it is reasonable to assume that loneliness could lead to metabolic syndrome.

### **Loneliness and Metabolic Syndrome**

Research examining the association between loneliness and metabolic syndrome is limited but results from two studies are suggestive regarding a potential relationship. In a study conducted by Whisman (2010), the cross-sectional association between loneliness and metabolic syndrome was evaluated using epidemiological data from over 3,000 middle-aged and older adults living in England. Adjusting for demographic variables and smoking status, results indicated a significant and positive relationship between loneliness and meeting criteria for metabolic syndrome overall and the specific component of central obesity. This confirms prior



research investigating the relationship between loneliness and obesity. Results also suggest that the relationship between loneliness and metabolic syndrome was not moderated by age.

Henriksen and colleagues (2019) studied the longitudinal association between loneliness and metabolic syndrome. The study consisted of over 26,000 participants in Norway and was conducted over the course of 10 years. The researchers discovered that loneliness was significantly and positively associated with incidence of metabolic syndrome and that this relationship was mediated by depression. Therefore, higher levels of loneliness led to higher levels of depression which in turn led to higher incidence of metabolic syndrome.

### **Current Study**

The current study was conducted to build on prior research examining loneliness as a potential risk factor for and metabolic syndrome. Specifically, the study was designed to evaluate the longitudinal association between loneliness and metabolic syndrome in a large population sample of English adults. In addition, the study sought to examine the degree to which loneliness was associated with incidence of the specific risk components of metabolic syndrome to provide a more comprehensive understanding of the specific aspects of metabolic syndrome that may be impacted by loneliness. It was hypothesized that loneliness would be significantly and positively associated with incidence of metabolic syndrome, as well as incidence of each of the components of metabolic syndrome.

## **Method**

### **Participants**

The study sample was obtained from the English Longitudinal Study of Aging (ELSA) which investigated health, economic, physiological, and social experiences of older adults living in England (Marmot et al., 2009). The sample included people 50 years of age and older living

in private households in England. The current analyses are based on individuals who completed the measure of loneliness in Wave 2 (2004-2005) and completed the Wave 2 and Wave 4 (2008-2009) nurse visit. Therefore, Wave 2 served as the baseline assessment and Wave 4 served as the follow-up assessment. There were a total of 1,094 participants, 46.3% of which were men, and they had a mean age range of 62.21 years ( $SD = 7.01$  years). Most participants (72.6% of the sample) were married, 5.3% had never married, 12.3% were separated or divorced, and 9.8% were widowed. Participants greater than 80 years old were excluded from the nurse visit as it would be too physically taxing to have these participants fast. Participants were also excluded if they had ever had a fit or convulsion, a clotting or bleeding disorder, or were on anticoagulants.

## **Measures**

### ***Loneliness***

Loneliness was measured with the 3-item Loneliness Scale (Hughes, Waite, Hawkey & Cacioppo, 2004). The 3-item scale was adapted from the Revised UCLA Loneliness Scale (R-UCLA; Russell, Peplau, & Cutrona, 1980) and it has been shown to correlate highly with the full scale and to demonstrate good internal consistency and concurrent and discriminant validity (Hughes et al., 2004). The three items were: “How often do you feel you lack companionship?” “How often do you feel isolated from others?” and “How often do you feel left out?” (Russell et al., 1980). Items were rated on a 3-point scale (*hardly ever/never*, *some of the time*, and *often*) and items were summed to yield a total score, with higher scores indicating greater loneliness ( $\alpha = .79$ ).

### **Metabolic Syndrome**

To measure metabolic syndrome, blood pressure measurements and blood samples were obtained from willing and physically able participants along with measures of waist

circumference as part of a nurse visit. Metabolic syndrome was defined using the International Diabetes Federation (2006) criteria which is defined as having central obesity and any two of the following four factors: raised triglycerides, reduced HDL cholesterol, raised blood pressure, or raised fasting plasma glucose. Central obesity was defined as waist circumference greater than or equal to 102cm in men and 88cm in women, raised triglycerides was defined as greater than 150 mg/dL for men and women (or specific treatment for this lipid abnormality), reduced HDL cholesterol was defined as less than 40 mg/dL for men and 50 m/dL for women (or specific treatment for this lipid abnormality), raised blood pressure was defined as greater than or equal to 130/85 mm|Hg (or treatment of previously diagnosed hypertension), and raised fasting plasma glucose was defined as greater than or equal to 100 mg/d (or previously diagnosed type 2 diabetes).

### **Data Analysis**

Logistic regression analysis were conducted to examine the association between loneliness at baseline and incidence of metabolic syndrome and each of its components at follow-up. Analyses were limited to participants who did not meet criteria for metabolic syndrome at baseline. To examine the association between baseline loneliness and incident metabolic syndrome at follow-up, metabolic syndrome status at follow-up (0 = did not meet criteria; 1 = met criteria) was regressed on loneliness and the demographic covariates of age, relationship status (married or cohabiting vs. everyone else), and gender (male or female).

Logistic regression analyses were conducted on weighted data using the Taylor series linearization methods as implemented in the Complex Statistics module of the SPSS software package, which incorporates the sample design into the data analysis, thus rendering acceptable standard errors of the parameter estimates. For ease of interpretation, the exponential of each

regression coefficient was computed and presented as an odds ratio (OR); the 95% confidence interval (CI) was also computed for each coefficient. Similar analyses were conducted for each of the components of metabolic syndrome. Each of these analyses were limited to people who did not meet criteria for metabolic syndrome and did not meet criteria for that specific component of metabolic syndrome.

### **Results**

Incidence of metabolic syndrome and each of its components at follow-up for people who did not meet criteria for metabolic syndrome at baseline are presented in Table 1. The mean level of loneliness was 1.34 ( $SD = 0.46$ ).

The results from the logistic regression analysis predicting incident metabolic syndrome from loneliness at baseline, adjusting for demographic characteristics, is presented in Table 2. As can be seen in this table, loneliness at baseline was not significantly associated with incident metabolic syndrome at follow-up.

Similar analyses were then conducted for incidence of each component of metabolic syndrome at follow-up. The results from these analyses are also presented in Table 2. As can be seen in this table, after adjusting for demographic characteristics, loneliness at baseline was not significantly associated with incidence of any of the components of metabolic syndrome at follow-up.

Although these results suggest that loneliness was not significantly associated with metabolic syndrome or its components, it is possible that the strength of the association between loneliness and metabolic syndrome differs across people, such that the association may be significant for some groups of people. To test this perspective, post hoc moderation analyses were conducted. First, analyses were conducted to evaluate the degree to which the strength of

the association between loneliness and metabolic syndrome varied by gender. A Gender  $\times$  Loneliness interaction term was created and entered into each of the preceding analyses; loneliness was mean deviated (i.e., centered) prior to creating the interaction term. After adjusting for the component terms (and the other demographic covariates), the interaction term was not significantly associated with metabolic syndrome (see Table 3), suggesting that the strength of the association between loneliness and metabolic syndrome did not differ by gender. Second, moderation analyses were then conducted to evaluate the degree to which the strength of the association between loneliness and metabolic syndrome varied by age. An Age  $\times$  Loneliness interaction term was created and entered into the logistic regression analyses predicting metabolic syndrome; age and loneliness were mean deviated prior to creating the interaction term. After adjusting for the component terms (and the other demographic covariates), the interaction term was not significantly associated with metabolic syndrome (see Table 3), suggesting that the strength of the association between loneliness and these outcomes did not differ by age.

### **Discussion**

The purpose of this study was to examine the degree to which loneliness was associated with the development of metabolic syndrome. Firstly, it was hypothesized that loneliness would be significantly and positively associated with the incidence of metabolic syndrome, such that higher loneliness would be associated with a higher incidence of metabolic syndrome amongst participants. Results failed to support this hypothesis, as loneliness was not significantly associated with incidence of metabolic syndrome. Secondary hypotheses were that loneliness would be significantly associated with incidence of the components of metabolic syndrome. Testing each component separately allowed evaluating whether loneliness was associated with

one or more components of metabolic syndrome, even if it wasn't significantly associated with the syndrome in full. Results failed to support these hypotheses as well, as loneliness was not significantly associated with scoring above the threshold for any of the components of metabolic syndrome at follow-up.

The lack of association between loneliness and incident metabolic syndrome observed in this study differs from the results obtained by Henriksen and colleagues (2019), who found that loneliness was significantly and positively associated with incidence of metabolic syndrome. There are several differences between the two studies that could account for the difference in results. Firstly, although the current study had a large sample ( $N = 1,094$ ), their study had a much larger sample ( $N = 26,990$ ) allowing for greater statistical power for testing the association between loneliness and incident metabolic syndrome. Second, the sample populations were different in the two studies. In the current study, the sample consisted of adults ages 50 years and older, but the study by Henriksen and colleagues (2019) collected data from participants as young as 20 years old. Perhaps, the association between loneliness and metabolic syndrome is more pronounced in younger people and the current study would have observed more similar results had younger participants been included. Also, the previous study by Henriksen and colleagues (2019) used a different measure to evaluate loneliness. They evaluated loneliness with a single question scale whereas the current study used a slightly more comprehensive, 3-question scale that had been tested for accuracy. It is possible the measure used in either study made for more accurate results. Finally, the study by Henriksen and colleagues (2019) was also conducted over a 10-year time period while the current study was only conducted on a 4-year period. There is a possibility that the 4-year follow up in the current study was not long enough

for the relationship to emerge and a longer time period would have found evidence for a longitudinal association between loneliness and incident metabolic syndrome.

The results of this study regarding central obesity are surprising considering what has been found in prior research. Research by Whisman (2010) found that loneliness was significantly and positively associated with waist circumference. However, these analyses were based on a cross-sectional design, suggesting that whereas loneliness may be associated with concurrent risk of large waist circumference, it may not predict incidence of this component of metabolic syndrome. The meta-analysis by Petitte and colleagues (2015) found that research investigating loneliness and obesity analyzed specific mediating factors in the relationship. One study referenced in the meta-analysis was a study by Stessmen and colleagues (2006), who found sleep to be a mediating factor while a study by Morse and colleagues (2006) found a mediating factor of night-eating symptoms. The research indicates that a relationship would likely be present even if mediating factors were involved. One would assume this was due to increased food consumption and the temptation to choose foods that are unhealthy and to eat more, resulting in increases in waist circumference. However, upon further review the many studies devoted to investigating the relationship between loneliness and obesity, most have mostly concentrated on young people which is not the demographic analyzed here. Conversely, in a study by Whitelock and Ensaff (2018), the researchers evaluated the association between loneliness and eating habits of older adults. They found that often loneliness led to less efforts made by participants to make meals and an overall lack of motivation to eat. In this study, it is possible that the lonelier participants had less motivation to eat and make food therefore leading to what would possibly appear as more healthy levels of the metabolic syndrome components which would explain the unusual data.

Given the lack of association between loneliness and metabolic syndrome, demographic characteristics of the sample were evaluated as potential moderators of these associations. Based on the perspective that the strength of the association between loneliness and metabolic syndrome may differ across individuals, analyses were conducted to test whether the association differed by gender or age. Results from these analyses suggest that neither gender nor age were significant moderators of the association between loneliness and incidence of metabolic syndrome. These results suggest that the strength of the association between loneliness and metabolic syndrome do not vary as a function of gender or age. Although these two demographic characteristics did not moderate the association between loneliness and metabolic syndrome, it is possible that there are other variables that do serve as moderators of this association.

### **Strengths and Limitations**

There were several notable strengths in this study. Firstly, the study is only the second study to examine the longitudinal association between loneliness and metabolic syndrome in a probability sample of adults, which is important for testing whether loneliness precedes and therefore is potentially causally associated with metabolic syndrome. Second, the study was based on a large and representative sample, and therefore the results are generalizable to the population of English adults 50 years of age and older. Third, the operational definition of metabolic syndrome was based on a gold standard definition and the assessment of loneliness was based on a brief version of the most commonly used measure of loneliness. A final strength of this study was that it analyzed all components of metabolic syndrome along with metabolic syndrome as a whole, giving a more complete picture of the longitudinal association between loneliness and this outcome.



The study also had several limitations which should be considered in interpreting the results. First, all the people in this study were all 50 years old and older. There is a possibility that loneliness may be associated with incidence of metabolic syndrome in younger individuals, and it would be important to investigate this possibility in the future. Another important potential limitation of the study was the length of time between assessment. The results were collected at baseline and a 4-year follow-up. There are any number of factors emotionally and physically that could occur over the course of those four years that could influence metabolic syndrome. Most importantly, level of loneliness may change over the course of four years, which would not be reflected in a single assessment at baseline. Research on the association between loneliness and metabolic syndrome would likely benefit from more frequent assessment of loneliness over time to provide a stronger test of the longitudinal association between loneliness and incidence of metabolic syndrome. Another limitation of the study involves use of the abbreviated UCLA Loneliness Scale (R-UCLA). Although the scale correlates highly ( $r = .82$ ) with the original UCLA Loneliness scale (Hughes et al., 2004), it is possible that use of the original scale would have provided a stronger test of the longitudinal association between loneliness and metabolic syndrome.

Based on the results of this study, there are several directions for future research to better understand the potential association between loneliness and metabolic syndrome. Firstly, future research could concentrate on investigating potential moderating factors as it could explain why some studies yield significant results regarding this association whereas other do not. For example, if a demographic variable was shown to moderate the association between loneliness and metabolic syndrome, then a study that included a larger percentage of people with the characteristic found to result in stronger associations between loneliness and metabolic

syndrome. Other potential moderators for future research could include socioeconomic status and relationship satisfaction. Similarly, this study consisted primarily of married participants, and future research could evaluate whether loneliness is a stronger predictor of metabolic syndrome for people who are not married. Finally, conducting research on a shorter interval between assessments or with more frequent assessments of loneliness over the follow-up interval could provide a stronger test of the association between loneliness and metabolic syndrome.

Loneliness and the influence it has on our mental and physical health should be investigated further due to its pervasive nature and potential for severe consequences. Studies have shown the issue of loneliness is very common especially amongst older adults (Chawla et.al., 2021), and has even been shown to be a risk factor for mortality (Rico-Uribe et. al, 2018) amongst other health problems making it extremely important to study further. Not only should research be concentrated on the ways in which loneliness influences our health and health behaviors, but on how to improve loneliness as well. In a meta-analysis by Hickin and colleagues (2021), the researchers found that psychological interventions were effective at reducing loneliness amongst participants across ages, cultures, and populations making it possible to prevent the many issues loneliness may cause. Further research can better inform healthcare providers in their understanding and treatment of those experiencing loneliness and the ways in which loneliness may influence health improving the overall well-being of the many who experience loneliness.

In conclusion, results from this 4-year longitudinal study involving a probability sample of English middle-aged and older adults suggest that baseline loneliness was not significantly associated with incidence of metabolic syndrome or its components. The possibility remains that there is a longitudinal association between loneliness and metabolic syndrome for some

subgroup or subgroups of individuals (i.e., that the association is moderated by some other variable) or that loneliness may be associated with incidence of metabolic syndrome and its components measured during a different time interval. Given that loneliness has been shown to impact other important health outcomes, continued research is needed on evaluating the pathways by which loneliness impacts health and mortality, including the possibility that it does so through the pathway of increasing risk for at least some components of metabolic syndrome.

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**Table 1***Incidence of Metabolic Syndrome and Its Components*

Outcome	Incidence
Metabolic Syndrome	10.1%
Central obesity	33.5%
Raised triglycerides	18.6%
Reduced HDL cholesterol	4.6%
Raised blood pressure	30.4%
Elevated fasting glucose	3.7%

**Table 2**

*Results from Logistic Regression Analyses Evaluating the Association Between Loneliness and Incidence of Metabolic Syndrome and Its Components*

Outcome	<i>B</i>	<i>SE</i>	<i>OR</i>	95% <i>CI</i>		<i>p</i>
				Lower	Upper	
Metabolic syndrome	.225	.229	1.252	0.798	1.965	.328
Central obesity	-.089	.183	0.915	0.639	1.310	.626
Triglycerides	.355	.232	1.426	0.904	2.249	.127
HDL cholesterol	-.372	.454	0.689	0.282	1.682	.413
Blood pressure	.279	.221	1.322	0.856	2.041	.207
Fasting glucose	-.627	.577	0.534	0.172	1.660	.277

*Note.* Tabled values represent the association between loneliness and the outcome, adjusting for age, gender, and marital status. OR = odds ratio. CI = confidence interval.

**Table 3**

*Results from Logistic Regression Analyses Evaluating Age and Gender as Moderators of the Association Between Loneliness and Incidence of Metabolic Syndrome*

Moderator	<i>B</i>	<i>SE</i>	<i>OR</i>	95% <i>CI</i>		<i>p</i>
				Lower	Upper	
Age	-.005	.032	0.995	0.934	1.060	.882
Gender	-.499	.480	0.607	0.236	1.560	.300

*Note.* Tabled values represent the association between the interaction term and metabolic syndrome, adjusting for the component terms and the demographic covariates. OR = odds ratio. CI = confidence interval.