

ECG Analysis to Study Social Connections in Older Cardiac Patients

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Abstract

Loneliness in older adults is associated with functional decline, depression and even death. Given the prevalence of loneliness, the aim of this study was to examine the association between loneliness and cardiac biomarkers in older people that attend to cardiology consultation. The results showed that loneliness was more prevalent in women than in men, and it was associated with marital status too. ECG recording were analyzed and QT interval and T-wave length showed higher values in people suffering from loneliness, as well as higher cardiac frequency, where the presence of meaning in life be a protective factor. Studies with a larger sample size are needed, but these results appear to show a relationship between biomarkers and mental state.

1. Introduction

Loneliness and social isolation are much more complex and have greater significance for health and well-being than is often perceived [1,2]. Numerous research studies reflect the importance of loneliness as a psychosocial factor influencing the individual human experience and societies. At the individual level, loneliness in older adults is associated with functional decline, depression and even death [3–5]. Recent studies show that older adults who are isolated are likely to become sicker and die earlier than those who feel connected, reporting that 20-30% of older adults in North America and Europe feel lonely [6, 7].

Given the prevalence of loneliness, the aim of this study was to examine the association between cardiac biomarkers and loneliness in older adults.

The field of biomarkers has rapidly expanded as a possible means to improve the management of different diseases with obvious relevance to improving the quality of life of patients. "Biomarker" is a general term used to describe a wide range of biological parameters, from measurable sub-

stances such as enzymes or hormones to characteristics in physiological tests such as biomedical signals, for example electrical signals recorded by means of electrocardiograms, which can be used in the assessment of disease. A large number of studies have identified a wide range of risk factors associated with cardiovascular disease. These can be classified into two groups: non-modifiable and modifiable risk factors [8,9]. The former includes demographic characteristics (e.g. age, sex, ethnicity) and family history. And the second can be divided into three categories: (1) biological conditions, such as obesity, diabetes, hypertension, etc., (2) psychosocial factors, such as stress, anxiety, etc., and (3) behavioural measures, including sleep, physical activity, smoking, diet, etc. Therefore, loneliness is among the modifiable risk factors.

On the other hand, having a purpose in life can mitigate loneliness and therefore have a positive impact on health and well-being [10], however, limited research has been conducted on loneliness and life purpose in older people. In this way, the aim has been to analyse whether biomarkers can help to detect unwanted loneliness and learn more about its causality. Thus, we have analysed the relationship between loneliness and life purpose and the effect of resilience and its relationship with cardiac biomarkers.

In this study we seek to understand the relationship between loneliness and meaning in life and its relationship with cardiac cardiac biomarkers.

2. Materials & Methods

This is a cross-sectional study that analyses a significant sample of patients over 65 years of age who attend cardiology consultations in the Hospital Virgen de la Luz in Cuenca. Consecutive sampling was carried out and justifies a sample size of 188 people in order to make an error of 5%, with a confidence level of 95%. The questionnaires were handed out at the end of the consultation to eligible patients who agreed to participate in the study by signing the informed consent form. Moreover, an ambulatory ECG

was registered and the clinical history was provided. Inclusion criteria were age less than 65 years and being a patient of the cardiology service and living in Cuenca and exclusion criteria were cognitive impairment and/or cardiac arrhythmia.

Table 1. Characteristics of Participants at Baseline.

Age	Gender		Total
	Women	Men	
65-74	44	41	85 (45%)
75-84	46	39	85 (45%)
85-94	10	8	18 (10%)

The Meaning of Life Questionnaire (MLQ) validated by Michael F. Steger [11] was provided in the validated Spanish version that assesses two dimensions of meaning in life using 10 items rated on a seven-point scale. The MLQ was scored on a seven-point scale from "Absolutely true" to "Absolutely false". The Presence of Meaning subscale measures the degree of meaningfulness that respondents feel in their lives. In addition, the Search for Meaning subscale measures the degree to which respondents are engaged and motivated in their efforts to find meaning or deepen their understanding of meaning in their lives.

Loneliness was also assessed using the De Jong Gierveld (DJG) loneliness scale. The 11-item DJG scale, validated in Spanish, includes a 6-item emotional subscale (negatively worded) and a 5-item social subscale (positively worded). Recent studies suggest that the DJG scale may be a better choice in research specifically involving middle-aged and older adults [12]. Conceptually, isolation can be thought of as an objective lack of social contact or interaction, and loneliness as the subjective experience of lack of companionship, social interaction and bonding - both social and emotional - while isolation is an "objective" lack of bonding due to isolation at home, with little or no social interaction with others or access to outside activities.

Nevertheless, the main objective is the analysis of cardiac biomarkers to assess the relationship between loneliness and cardiac response. The biomarkers of the patients who will be part of the study contain electrocardiogram recordings as well as relevant related clinical data. The heart rate was obtained by automated analysis and extraction of R peaks from ECG signal acquired from every subject. In addition, signal processing techniques were applied to extract the following ECG waves for statistical analysis:

- T-wave
- ST segment
- QT interval

In addition, different variables related to the cardiological analysis were added. Among them are: HDL chole-

sterol, LDL cholesterol, hemoglobin, metabolic biomarkers, inflammatory markers (C-reactive protein . . .), neurohormones, bilirubin, blood urea, uric acid, creatinine, sodium, blood glucose, creatinine (kidney function), diabetes, blood pressure (hypotension or hypertension), diastolic pressure, systolic Pressure, neurological Consultation, family cardiological history, stroke, arrhythmias, heart disease, alcohol, smoking, overweight and other observations.

2.1. Statistical Analysis

Statistical analysis will be planned starting with descriptive statistics and followed by analytical with estimation of measures of risk, impact, validity or precision and hypothesis testing. Frequency measures of discrete variables and measures of centralisation and dispersion of continuous variables were assessed. It was also included the estimation of frequency measures (prevalence, cumulative incidence, incidence density, etc.). All estimates are accompanied by their 95 % confidence intervals.

3. Results

The dichotomization of the response to loneliness, showed a frequency of people who did not feel lonely 76.8%, compared to 23.2% of people who were lonely (Figure 1).

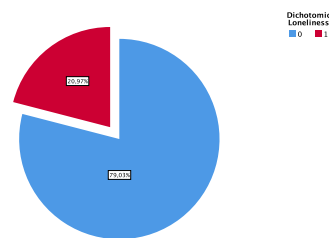


Figure 1. Distribution of the population in terms of perception of loneliness.

Reliability analysis of the scales used confirmed a Cronbach's Alpha based on standardised items higher in all cases than 0.770 and reaching 0.928 for the purpose in life scale in the analysis of the "search for meaning in life" variable. Furthermore, differences were found in the perception of loneliness in those who felt that life had meaning and those who did not, Pearson's chi-square =130.01; $p < 0.001$. (Figure 2)

Moreover, a greater presence of loneliness was observed in those whose heart rate was higher ($p=0.018$), with 67.77 ± 14.86 bpm vs. 73.11 ± 13.49 bpm, in the group that did not express loneliness compared to the group of people who felt lonely (Figure 3).

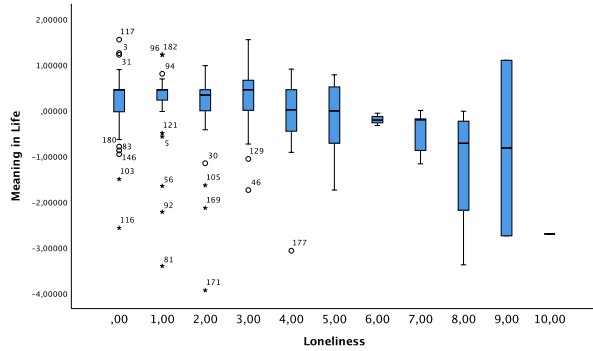


Figure 2. Presence of purpose in life in relation to loneliness

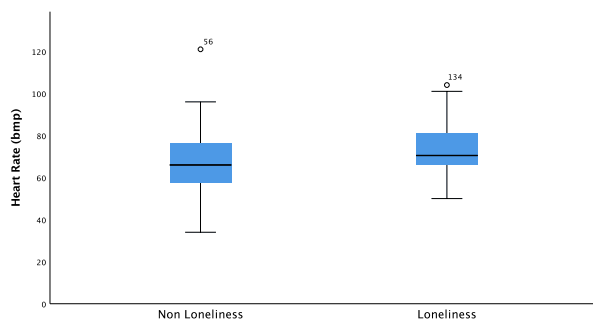


Figure 3. Heart rate in relation to loneliness.

With respect to the ECG measurements, it was found that the people with a longer QT interval perceived loneliness, with 398.97 ± 43.41 ms vs. 385.13 ± 37.85 ms in the group of people who did not feel lonely, ($p=0.024$). Moreover, the T-wave followed the same trend (121.64 ± 11.74 ms vs. 115.26 ± 7.62 ms, $p=0.025$), indicating that people who perceive their relationships with others to be less than they would like have longer ECG intervals.

The variables extracted from the ECG have a stronger relationship with social loneliness than with emotional loneliness, as shown by the high Pearson correlation values. emotional loneliness, as shown by the high values of Pearson's correlation (0.333 , $p<0.001$, Figure 4, as well as meaning in live (0.300 , $p<0.001$, Figure 5)

Methods such as linear regression were also applied, in which the dependent variable loneliness was related to the variables studied, obtaining two variables with high predictive power: the presence of meaning in life and heart rate.

4. Conclusions

Results show a relation between heart response and loneliness. Previous studies confirm similar results, where

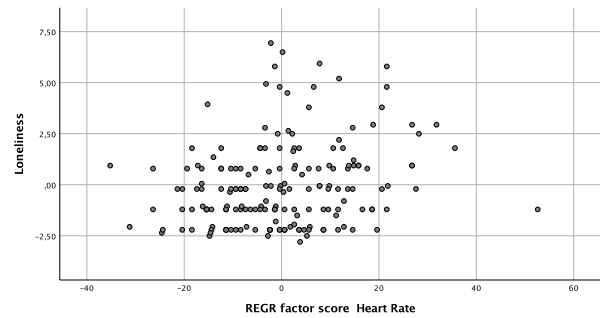


Figure 4. Dependent variable, loneliness in relation to heart rate.

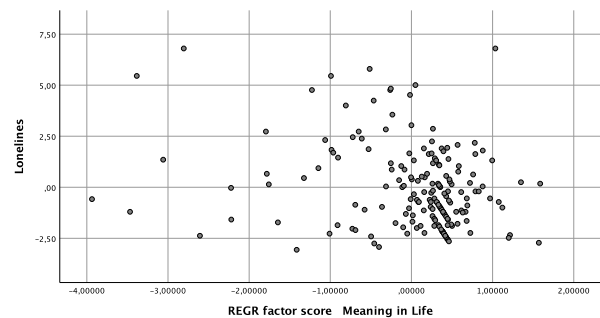


Figure 5. Dependent variable, loneliness in relation to meaning in live.

social isolation and inability to relieve anger by talking to others were associated with decreased heart rate variability, nevertheless, depressive symptoms were related only to the LF/HF ratio [13]. Moreover, other studies affirm that the combination of coronary artery disease and mental stress-provoked silent ventricular dysfunction were distinguished by a psychological profile consistent with emotional reactivity to social interaction and mental provocation, with anger as the predominant affective state, thus these patients with such a profile may be at risk of frequent silent left ventricular dysfunction [14].

Moreover, previous studies have evaluated the electrophysiological mechanisms of stress: T-wave alternants, as well as other ECG measures of heterogeneity of repolarization, increases with emotional and cognitive stress in the laboratory setting, and may also in "real life" settings [15]. In this work, QT intervals are shown to be higher in people suffering from loneliness, also with an increased heart rate, these results show the same trend that the induced by psychological stress [16]. Then, it should be interesting to complement this work with a more deeply analysis of the changes that occur in the changes in the QT interval, as well as in depolarization heterogeneity, long recognized

as an important factor in arrhythmogenesis, by measuring T-wave alternants, T-wave amplitude and T-wave area in more depth.

Based on our findings, it would be advisable to carry out interventions aimed at reducing stress, which can be linked to loneliness and, at the same time, to spread protective factors, such as the presence of meaning in life and the achievement of goals and objectives, in order to reduce the physiological impact of loneliness on the organism. It is also interesting to analyse the causality of the relationship between psychosocial factors and heart disease. However, further research is needed both traditional and complementary psycho-educational approaches are needed to develop a useful prototype for older people in order to understand their relationship with heart disease and other loneliness-related illnesses.

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