Decreases in depression over 20 years in a mining area of Sardinia: due to selective migration?

Short title: Decreases in depression in a mining area

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ABSTRACT
Background

The objective of the study was to determine if community surveys, conducted 3 times over a period of 20 years in a small district of Sardinia (Italy), confirm the increase in depressive disorders reported in the recent literature.

Methods

Three community surveys were carried out on randomized samples of the same Sardinian mining area in 1988, 1998 and 2008. The surveys were conducted using the interview “Present State Examination” in 1988 (Depression diagnosed with ICD-IX) and the CIDI-S in 1998 and 2008 (Major Depression diagnosed with ICD-X). The three surveys produced estimates of one-month prevalence and of lifetime prevalence in 1998 and 2008.

Results

Our work found a substantial decrease in depressive disorders from the survey conducted in 1998 to the survey in 2008 using a similar methodology, except in the youngest age group, which showed an increase in the rate. A decrease in the frequency of depressive disorders compared to what was found 20 years ago was also observed. However, in this case the comparison is more problematic because of use of different diagnostic systems.

Discussion

The research seems to show a decrease in depressive disorders over the past two decades. While the small population examined makes it difficult to generalize the overall findings, this study suggests that the hypothesis of an increase in the incidence of depressive disorders since the 1980s in western countries, should have exceptions. A complex interaction between socio-economic (mining closure and large migration) and biological factors (possible selective migration) is likely to influence changes in the prevalence of mood disorders. However, due to certain limitations of this study, this hypothesis may be considered from an heuristic perspective.
Introduction

Not much is known about large-scale changes in the prevalence of Major Depressive Disorders over a period of time (Compton et al., 2006; Goldney et al., 2010). This topic is of importance to public health due to the fact that depression is very common, often subclinical, costly, and disabling and is one of the most burdensome disorders worldwide (Grant et al., 2004; Goetzel et al., 2003; Murray and Lopez, 2006).

The hypothesis that there is an increase in the incidence of depression in the western countries was prompted by an earlier longitudinal study from Sweden (Hagnell et al., 1982). This study found increasing rates of depression from the 1940s through the 1970s. Subsequent reviews of the literature, carried out in the 1980s, suggested temporal changes in the rates of major depression: an increase in rates in the cohorts born after World War II and an increase between 1960 and 1975 in the rates of depression for all ages (Klerman and Weissman, 1989). Recent US (Compton et al., 2006) and Australian (Goldney et al., 2010) surveys confirmed the hypothesis of a trend of increasing depression over the decades.

The apparent increase in the major depressive disorders has profound health care and economic implications. If the prevalence of depression continues to increase, as indicated by these above studies, demand for services will increase dramatically in the future and may outstrip the capacity of service delivery systems. Similarly, clinicians can expect to encounter depression more frequently in their practices, especially among young adults (Compton et al., 2006). While national studies to determine changes in the prevalence of depressive disorders over time
are essential, longitudinal studies carried out over time in smaller but well defined communities may provide valuable complementary information. Moreover, a comparison of depression rates over time in small well-defined communities versus large populations may be important to generate pathogenetical and socio-economical hypotheses underlying depression. In fact, studying small communities, being relatively isolated, can generate hypotheses with respect to specific risk factors, which are otherwise more difficult to study in large population surveys.

The objective of this study was to determine whether a small community survey in Sardinia (Italy) confirms the increase in the depressive disorders detected by the recent studies in North America and Australia and what factors might be responsible for the changes, if any, in the frequency of depressive disorders over time.
Methods

The area covered in this study is a mining region of southwestern Sardinia, with about 5,000 inhabitants (the townships of Fluminimaggiore and Buggerru) where three epidemiological surveys were conducted on the prevalence of psychiatric disorders in 1988 (Mining I survey), 1998 (Mining II survey) and 2008 (Mining III survey).

The study design and the sampling techniques of the first two surveys have been already published (Carta et al., 1991; Carta et al., 2002). In the 1988 study, the sample was constructed by random selection after stratification by sex and age (into 8 classes) from the municipality’s registry of the two villages, Fluminimaggiore and Buggerru. The study sample represented 10% of the population. The survey was conducted by physicians with psychiatric training using the semi-structured clinical interview “Present State Examination” (Wing). The survey produced estimates of prevalence over a period of one month and diagnosed with the ICD-IX system (WHO, 1977). Interviews were conducted on 374 subjects, 94.4% of the total extracted sample (174 males: 46.5%).

The surveys in 1998 and 2008 were conducted using a similar methodology with randomization after stratification by sex and age. Research conducted in 1998 also stratified a sub-sample of mining population in the municipalities of Fluminimaggiore and Buggerru (n = 303, male 141: 45.9%). The total sample of 1040 individuals from the published survey (Carta et al., 2002) represented three different areas and economic status of Sardinia (urban-industrial n = 393, rural-mining n = 303 [Fluminimaggiore and Buggerru], rural-agro-pastoral n = 344). The study sample was 10% of the population. In the mining sub-sample, for which data
are presented in this survey, 83.9% of the 361 selected subjects agreed to take part in the study.

The 2008 survey was conducted in the same townships of Fluminimaggiore and Buggerru. Participants were randomly extracted, after stratification by sex and age and represented 1/6 of the population, which is more than the 1/10 sampled in the previous surveys in order to increase the statistical power of the study.

The subjects of investigations of 1998 and 2008 were interviewed by physicians or psychologists who had at least 2 years of experience in psychiatry. The diagnostic tool used was the simplified CIDIS interview protocol of CIDI (Kovess, 1997). The interview was translated into Italian, back-translated to French and then validated (Carta et al., 2003). Psychiatric diagnoses were conducted using a computer algorithm through the ICD-X system (WHO, 1992).

Given the differences in obtaining the data in the first (1988) study and the two subsequent ones such as the use of different methodology (semi structured tools in the first survey versus structured clinical interviews in the others), and diagnostic systems (ICD-IX to ICD-X), caution should be exercised while comparing the results from the 1988 study to the later ones. However, the comparison between the surveys of 1998 and 2008 is less problematic since the surveys were carried out with the same diagnostic tool (CIDIS interview) and the diagnostic system (ICD-X).

**Ethical Aspects**

An informed consent for the use of anonymous data suitable for an aggregate study was signed by each candidate. The study was approved by the ethical committee of the Università Europea del Mediterraneo Onlus (Cagliari). Data were not nominal at source and each subject was identifiable with a code number.
Results

Of the 521 subjects of the randomized sample of the survey of 2008, 413 (79.27%) agreed to be interviewed. A no-participation in the interview was more frequent among males (78, 36.9%) than among females (30, 9.2%). In total, 141 interviews were generated from male subjects (34.1%) and 272 interviews from female subjects (65.9%).

Tables 1 shows the comparison by sex in the frequency of lifetime Major Depression (ICD-X) determined in surveys of 1998 and 2008. The data were split by sex (male versus female) in four age groups, 18-24 years, 25-44 years, 45-64 years and 65 years and over. In both sexes, all age groups except the young 18-24 group showed a trend towards lower frequencies in the 2008 study compared to the 1998 study. The trend is statistically significant when we consider the total number of males (the sum of all age groups, including the 18-24 age group), the total number of males and females in the 24-45 age group, and all the subjects in the sample (sum of males and females).

Table 2 shows the comparison of one month prevalence of Depressive Episodes in 1988, 1999 and 2008 in the mining population sample. The Depression was diagnosed in 1988 as classes N and R of ICD-IX, whereas in the two subsequent surveys, as major depression ICD-X. The trend in the prevalence % of the depressive episode in the mining region is stated as follows: 1988: 10.1%, 1998: 6.9%, 2008: 3.1%.

Table 3 compares the rates reported by the 1988 survey (Mining I survey) with those obtained from similar research conducted in Europe over the same period from the reviews of Bebbington (1990) and Horwath and Weissman (1995). The one month prevalence of Depressive Episodes (diagnosis through the ICD-IX
CATEGORY PSE algorithm) in the mining area of Sardinia is the highest in Europe and is also clearly outside the range of frequencies reported from other European studies, the frequency being about twice that of frequencies reported by most other studies, with the exception of two Greek studies (Mavreas and Bebbington, 1988), which, had a rate of about 30% lower compared to the Sardinian study.

Table 4 compares the rates reported by the Mining III survey (2008) with those obtained from similar studies conducted in Europe over the same period (from Paykel et al., 2005). The prevalence of the depressive episodes per year highlighted by this Sardinian study is among the lowest, and therefore, is in the range of European studies, and is also close to the Italian sample of the ESEMeD study (Alonso et al., 2004).

Table 1. Comparison of the lifetime prevalence frequencies of Depressive Episodes (ICD-X) by sex and age in Mining survey II (1998) and III (2008).
Table 2. Comparison of the one month prevalence of Depressive Episodes (ICD-X) in Mining surveys I (1988), II (1998) and III (2008).


<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Males (M)</td>
<td>13 (7.4)</td>
<td>9 (6.4)</td>
<td>3 (2.1)</td>
<td>0.27</td>
<td>0.07-1.07</td>
<td>3.49</td>
<td>0.062</td>
</tr>
<tr>
<td>Females (F)</td>
<td>25 (12.5)</td>
<td>12 (7.3)</td>
<td>10 (3.7)</td>
<td>0.27</td>
<td>0.03-0.58</td>
<td>11.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>M + F</td>
<td>38 (10.1)</td>
<td>21 (6.9)</td>
<td>13 (3.1)</td>
<td>0.29</td>
<td>14.6</td>
<td>0.0001</td>
<td>0.92</td>
</tr>
</tbody>
</table>
Table 3. Comparison of the results from the Mining survey I (1988) with other studies from the same period that used similar methods** (Depression PSE CATEGO ICD-IX)

<table>
<thead>
<tr>
<th>Study</th>
<th>Time</th>
<th>Diagnosis</th>
<th>Period Prevalence</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining I- Sardinia</td>
<td>1988</td>
<td>PSE/ICD IX</td>
<td>1 month</td>
<td>10.1</td>
</tr>
<tr>
<td>Nijmegen, NL</td>
<td>1987</td>
<td>PSE/ICD IX</td>
<td>1 month</td>
<td>5.4</td>
</tr>
<tr>
<td>Camberwell, GB</td>
<td>1981</td>
<td>PSE/ICD IX</td>
<td>1 month</td>
<td>7.1</td>
</tr>
<tr>
<td>Athens, Gr</td>
<td>1988</td>
<td>PSE/ICD IX</td>
<td>1 month</td>
<td>7.4</td>
</tr>
<tr>
<td>Greek Immigrants in London</td>
<td>1988</td>
<td>PSE/ICD IX</td>
<td>1 month</td>
<td>5.6</td>
</tr>
<tr>
<td>Santander, E</td>
<td>1986</td>
<td>CIS/ICD IX</td>
<td>1 month</td>
<td>4.6</td>
</tr>
<tr>
<td>Finland (two districts)</td>
<td>1990</td>
<td>PSE/ICD IX</td>
<td>1 month</td>
<td>4.6</td>
</tr>
</tbody>
</table>

**Modified from Horwarth and Weissman, 1995 and Bebbington, 1990

Table 4. Comparison of the results from the Mining survey III (2008) with other studies from the same period that used similar methods* (Depressive Episode ICD-X or Major Depressive Disorder DSM-III or DSM-IV)

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Diagnosis</th>
<th>Period Prevalence</th>
<th>Prevalence %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESEMeD I,E,B,F,D,NL</td>
<td>2000-2002</td>
<td>CIDI-DSM</td>
<td>1 year</td>
<td>3.9</td>
</tr>
<tr>
<td>Finland</td>
<td>2000</td>
<td>CIDI-ICD-X</td>
<td>1 year</td>
<td>5.0</td>
</tr>
<tr>
<td>Lower Normandy (France)</td>
<td>1998</td>
<td>CIDI-ICD-X</td>
<td>1 year</td>
<td>3.4</td>
</tr>
</tbody>
</table>
Discussion

The most recent survey performed in 2008 (Mining survey III) shows a substantial decrease in the rates of depressive disorders from the previous survey conducted 10 years before, both using similar methodology. However, the youngest age group showed the opposite trend of increasing rates. It has been hypothesized that there is an increase in the incidence of depression in the western society over the years. Contrary to this expectation, we found that lifetime frequency of depressive episodes decreased in the total sample (from 17.8% to 10.6%), in males (from 15.8% to 8.5%) and markedly in adults 24 to 45 years of both sexes (from 17.0% to 6.9%).

A decrease in the frequency of depression in the same community was also found when compared to a prior survey conducted 20 years earlier (Mining I survey). In this case, however, the comparison is more complicated because of difference in the diagnostic systems used. The diagnosis of depressive episode obtained through the “Present State Examination” interview, which was used in 1988, is the sum of "neurotic", "reactive" and "psychotic" depressions for the old nomenclature. Conversely, the diagnosis of depressive episode according to ICD-X obtained through the CIDI-S interview in 2008 excluded Dysthymia, entity that is considered individually in the diagnostic system adopted by the WHO in 1992. It is therefore a
more restrictive diagnosis. Although it is arbitrary and sometimes misleading to compare rates obtained in population studies using different methodologies and different diagnostic systems (Fryers et al., 2004), the data is highly suggestive of a real decrease in rates of depression. Moreover, in the survey of 2008 the prevalence is quite low compared to the 1988 survey (3.1% versus 10.1%), the difference being statistically significant. The survey of 1998 shows an intermediate prevalence compared to the surveys of 1988 and 2008 and corresponds to a rate of 6.9%.

Furthermore, the decreasing trend of depressive episodes can be seen by comparing the parallel Mining I and Mining III surveys with studies conducted elsewhere in Europe over the same period using similar methodologies (PSE-ICD-IX in Mining I and CIDI-DSM-IV in Mining III). The 1988 Mining I Sardinian study showed the highest rate in Europe (Bebbington, 1990) with about 30% more in depressive episodes in terms of severity and frequency compared to the rates in other European studies. Twenty years later, the prevalence rates of depression reported by the Mining III study is within the range of the main European studies (Paykel, 2005) (see Table 4). It should also be noted that with respect to the Mining II survey, the rates were within the mid to upper limits range of the European findings (European Commission report, 2004). This indicates an intermediate situation compared to Mining I and Mining II surveys in relation to the European results. In conclusion, while the first study yielded prevalence rates well above the other European studies and the second survey showed higher rates, but close to those found in other European studies. In contrast, the Mining III survey results are within the range reported in other European studies, and is one of the lowest rates. Interestingly, these results are similar to those found by the ESEMeD study in Italy (Alonso et al., 2004), 3.1% versus 3.9%.

In summary, these findings indicate a decreasing trend in the rate of depressive disorders over time. On the other hand, depression among young people shows an opposite, increasing trend. These results are counter to those earlier surveys reviewed by Klerman and Weissman (1989), a recent American study (Compton et al., 2006) and and Australian survey (Goldney et al., 2010). The US study, using data from two large, representative surveys of the adult U.S. population, one conducted in 1991–1992 (Grant et al., 1992), and the second in 2001-2002 (Grant
et al., 2004), showed that the rates of major depressive episodes rose markedly over the past decade in the United States. Moreover, the increases were noted for most socio-demographic subgroups of the population (Compton et al., 2006). These results are not consistent with an increase in the prevalence of depression specific to a particular age cohort at a particular point in time, since both older and younger groups showed increased rates of depression. The prevalence of major depression increased significantly in the South Australian study as well, from 6.8% to 10.3% between 1998 and 2008. However, significant increases were observed only in males aged 15-29 and females aged 30-49 years, but, not in any other sub-groups (Goldney et al., 2010).

How can we explain the opposite trend that we observed compared to the other studies? There may be several reasons. The one month and lifetime prevalence in depressive episodes in a limited population, may decrease over time due to a) a decrease in the percentage of new cases reported, b) shortened length of episodes due to the introduction of an effective treatment regimen, or c) an exit from the study of those with chronic depression due to specific high mortality, or selective emigration.

Let us first examine the last point. A specific increase in mortality is more likely due to such causes as suicide, which afflicts a very high percentage of individuals with depression. In our study area there were 9 suicides in the last 20 and 4 in the last 10 years which comes out to a stable rate of about 10 suicides per 100,000 inhabitants per year. This is similar than the regional, and much higher than the national average. However, the trend of suicide is constant since the 1980s in Sardinia (Regione Sardegna report, 2010). Thus suicide is very unlikely to be responsible for the marked change in the frequency of depressive episodes over study duration. This is because of the relatively low frequency of suicide compared to the prevalence of depression in this area (4/100,000 against 6-3/1000).

The use of more efficacious treatment as a possible factor in reversal of the one month depressive episodes trend is also unlikely. This is because, while the use of antidepressants increased from 8% (Carta et al., 1991) to 29% (Carta et al., 2003) between the 88’ and 98’ surveys, this augmentation is similar in all European
countries during this time frame (Carta et al., 2004). Furthermore, the use of antidepressants in a large Italian sample representative of six Italian regions, including the area studied in this research, reached 53.6% in 2010 (Carta et al., 2010). Thus, while it is possible that the change in the pharmacological intervention may be a factor, it does not explain the significant reversal of trend observed in our study because such a phenomena was similar in all the western countries (in which on the contrary the depression increases). Therefore it is necessary to examine local factors that might have mitigated the increasing trend.

The hypothesis of "selective" emigration, that depressed individuals are more likely to leave, also does not explain the reversal of the trend at least if we examine just the time of the study. Because, although that the population of the area studied underwent a slight decrease, due high unemployment, emigration was stronger from the '60s to the '80s when there were massive closure of the mines. Similarly, the hypothesis of selective return of depressed individuals is also not a major factor. That is, only about 100 emigrants had returned in the last 10 years prior to the undertaking of the study out of about 4300 permanent residents. Previous studies have shown that this runs counter to a risk of developing depression (Carta et al. 1995). The immigration of foreigners who became permanent residents, was also negligible, with only 15 individuals over the past 10 years. Similarly, emigration of individuals of other national and regional residents was negligible during the period of observation (50 individuals between mining I and II).

It is necessary to point out the strong economic and social changes that have gone through the area prior to the studies. The last mine closing occurred in 1987, a process that began in the early 60s and ending just before the commencement of the first survey. It should be noted that in the two decades prior to the mining I survey (1958-88) the population of the area decreased dramatically from about 8,000 to 5,000 inhabitants. This is due to the closure of mines in the area. A large proportion of those migrated were young adults who are part of the work-force.

One reason for migration was the economic difficulties, however, not all people with similar economic problems took the decision to migrate. Frequently, following the clausure of the mining, when a family has a small estate that was insufficient
for two or more brothers, one would stay and the others leave. Who stays and who leaves? In the Middle Ages, it was according to the birth order, but in Sardinia in the 1950s and 60s, it was not the case. The family jointly decided (Rudas et al. 1972). Thus, probably individuals with an attitude to explore or discover new ways, or men with ambitious objectives, with good activity skills, and with high self-esteem, were selected to emigrate, as a Sardinian survey on migration demonstrates (Rudas and al 1972).

According to this perspective, and consistent with existing evidence in literature, the migration should have selected individuals with “hypomanic temperament” (Gartner 2005), individuals with stable traits such as heightened energy, drive, ambition, confidence, creativity and risk tolerance. Gartner (2005) suggests that the high proportion of hypomanics arriving in country as immigrants may be one of the keys of the wealth of the new country. On the other hand, such individuals may also be at risk for mood disorders if they did not achieve their objectives and stayed back. Thus, such emigration selection may be also decrease the people at risk for mood disorders in the area. Therefore, a selective migration prior of the studies at the time of the mining closure may be the cause for the inverse trend of mood disorders in the mining area.

The reason for a lack of decrease in depressive disorders among young adults, and the evidence of an increasing trend in this age group in the most recent survey may be due to lack of migration of young adults “at risk” after the 80’s.

Limitations of the study

Our study has some significant limitations. First, the small size of the population studied. Second, the first survey was carried out with a different methodology compared to the other surveys. Finally the observational methodology of the study can be ineffective to verify a complex scenario, in this case, a community survey, although repeated over time, such as this one, has to be viewed only as a source for generating hypothesis/possibilities and the results must be considered only as an heuristic contribute.

Conclusions
Our study shows a decrease in the rates of occurrence of depressive disorders in the past decade in the population studied. It must be noted that the small and specialized population examined makes it difficult to generalize the overall findings of this study. However, cross-comparison with similar studies conducted elsewhere in Europe in the same period, allows us to suggest that it is a phenomenon characteristic of the area. The results should be compared with those of other studies in defined geographical areas, conducted during the same time period to test whether the decrease in the frequency of depression is a phenomenon common to other cultural realities as well. Nonetheless, our study suggests that a complex interaction between social (as social changes and specific migration) and biological factors (as vulnerability) may determine the change in the prevalence of mood disorders in these specific areas.

**Competing interests**

The authors declare that they have no competing interests.

**Authors' Contributions**

MGC participated in the design of the study, in the analysis of the data and performed the statistical analysis and drafted the manuscript. MEL, MFM, GMu, GMe and MCH participated in acquisition of data and critical revision of the manuscript. KMB participated in the design of the study, in the analysis of the data and drafted the manuscript. MA performed the statistical analysis and supervised the manuscript. All authors read and approved the final manuscript.

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