Mortality from Suicide in the Municipalities of Mainland Portugal: Spatio-Temporal Evolution between 1980 and 2015

Mortalidade por Suicídio nos Municípios de Portugal Continental: Evolução Espácio-Temporal entre 1980 e 2015

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ABSTRACT

Introduction: Suicide is considered a public health priority. It is a complex phenomenon resulting from the interaction of several factors, which do not depend solely on individual conditions. This study analyzes the spatio-temporal evolution of suicide mortality between 1980 and 2015, identifying areas of high risk, and their variation, in the 278 municipalities of Continental Portugal.

Material and Methods: Based on the number of self-inflicted injuries and deaths from suicide and the resident population, the spatio-temporal evolution of the suicide mortality rate was assessed via: i) a Poisson joinpoint regression model, and ii) spatio-temporal clustering methods.

Results: The suicide mortality rate evolution showed statistically significant increases over three periods (1980 - 1984; 1999 - 2002 and 2006 - 2015) and two statistically significant periods of decrease (1984 - 1995 and 1995 - 1999). The spatio-temporal analysis identified five clusters of high suicide risk (relative risk >1) and four clusters of low suicide risk (relative risk < 1).

Discussion: The periods when suicide mortality increases seem to overlap with times of economic and financial instability. The geographical pattern of suicide risk has changed: presently, the suicide rates from the municipalities in the Center and North are showing more similarity with those seen in the South, thus increasing the ruralization of the phenomenon of suicide.

Conclusion: Between 1980 and 2015 the spacio-temporal pattern of mortality from suicide has been changing and is a phenomenon that is currently experiencing a growing trend (since 2006) and is of higher risk in rural areas.

Keywords: Cause of Death/trends; Portugal; Spatio-Temporal Analysis; Suicide/statistics & numerical data

RESUMO

Introdução: O suicídio é considerado um problema de saúde pública. É um fenómeno complexo que resulta da interação de múltiplos fatores e que não depende unicamente de condições individuais. Este estudo pretende analisar a evolução espácio-temporal da mortalidade por suicídio em Portugal Continental, entre os anos de 1980 e 2015, identificando, nos 278 municípios, áreas de risco e suas alterações.

Material e Métodos: Com base no número de óbitos por suicídio e lesões autoinfligidas e na população residente, a evolução espácio-temporal da taxa de mortalidade por suicídio foi analisada através de: i) um modelo de regressão de Poisson *joinpoint*, e ii) métodos de clusterização espácio-temporal.

Resultados: A evolução da taxa de mortalidade por suicídio revelou três períodos de incremento (1980 - 1984, 1999 - 2002 e 2006 - 2015) e dois períodos de decréscimo (1984 - 1995 e 1995 - 1999) estatisticamente significativos. A análise espácio-temporal identificou cinco *clusters* de risco elevado de suicídio (risco relativo > a 1) e quatro *clusters* de risco baixo (risco relativo < a 1).

Discussão: Os períodos de aumento do fenómeno suicidário parecem coincidir com momentos de instabilidade económica e financeira. O padrão geográfico do risco de suicídio modificou-se: municípios da região Centro e Norte revelam valores próximos dos observados no Sul, amplificando a ruralização do fenómeno suicidário.

Conclusão: Entre 1980 e 2015 o padrão espácio-temporal da mortalidade por suicídio tem vindo a alterar-se, sendo atualmente um fenómeno com tendência evolutiva crescente (desde 2006) e de maior risco em territórios rurais.

Palavras-chave: Análise Espaço-Temporal; Causas de Morte/tendências; Portugal; Suicídio/estatística e dados numéricos

INTRODUCTION

Suicide has been widely considered as an important public health issue worldwide.[1] A 10.7 per 100,000 suicide rate has been estimated worldwide (2015)[2] and suicide is more prevalent in male and in people aged over 70.[1] In addition, suicide is among the ten leading causes of death worldwide and the second leading cause in the 15-29 age group.[1]

Suicide is a complex phenomenon related to the interaction between different factors apart from those that specifically depend on individual conditions (genetic, neurobiological). Emile Durkheim[3] was one of the leading authors on the analysis of suicide determinants, the potential impact of society and its organisation on individuals and how the individual behaviour could be affected by social environment.

Since then, the influence of different contextual factors on the risk of suicide has been analysed by different authors, including: poverty,[4,5] socio-economic deprivation,[6–9] low income,[10–12] unemployment,[10,13,14] poor access to

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facilities and services,[15,16] low exposure to green space,[17] rurality[18–20] and low density.[8,21,22]

Apart from this, there is a trend towards worse effects in moments of crisis, with increasing vulnerability and inequality and subsequently increasing suicide-related poor outcomes.[23–25] The association between suicide and characteristics related to periods of economic crisis and austerity has been shown by evidence-based research studies, mainly regarding the loss of socio-economic status, impoverishment, unemployment, the threat of eviction and debt.[14,26–32]

Evidence on the association between suicide-related mortality and the characteristics of the individual environment on a continental scale (municipality)[33] and on the metropolitan areas (parish) has been found by different Portuguese studies,[34,35] namely in times of economic and financial crisis.[33]

Suicide and self-inflicted injuries are among preventable causes of death receptive to primary prevention and healthcare promotion[36] directly or indirectly linked to the prevention of mental disorders. The analysis of geographical patterning of suicide has been highlighted in scientific literature, namely regarding the identification of excessive mortality within a space and throughout a certain period of time.[9,37–40] The knowledge on the spatio-temporal pattern of the phenomenon is crucial for the definition of strategies on i) prevention of suicidal ideation and suicide, aimed at the promotion of positive interaction of patients with their surrounding environments, reducing lifelong exposure to stressful events[41] and ii) mitigation of unfair spatial inequities, focused on higher-risk areas.

This study aimed at the analysis of the spatio-temporal evolution of suicide in Mainland Portugal between 1980 and 2015 and the identification of risk areas among 278 municipalities and their changes.

MATERIAL AND METHODS

Data

Secondary information has been collected from the Portuguese National Institute of Statistics (*Instituto Nacional de Estatística* – INE) regarding the 278 municipalities in Mainland Portugal on: i) the annual number of deaths from suicide (International Classification of Diseases - ICD, 9th revision, in effect up to 2001: E950-E959; ICD, 10th revision, in effect from 2002: X60-X84), from 1980 to 2015, ii) the resident population on census years 1981, 1991, 2001 and 2011 and iii) the annual estimated population, from 1980 to 2015.

Methods

A log-linear regression model has been applied for the identification of change in trends (joinpoint)[42] regarding suicide rate and for the estimation of the mean annual relative variation over each of the identified periods throughout 1980 to 2015. The analysis has started with the minimum number of joinpoints and tested whether the inclusion of new joinpoints was statistically significant.[43] Each joinpoint showed a statistically significant change in time trend within the final model and the mean annual relative variation is subsequently calculated for each period. The Joinpoint Regression Program 4.1.1 software has been used for the identification of these trends.

The space-time cluster identification method developed by Martin Kulldorff[45] has been used for the identification of risk areas regarding suicide rate in space and time,[44] allowing for the clustering of municipalities showing suicide rates above or below the expected value for each period of time. This method allowed for a space-time retrospective analysis by using the Poisson distribution and subsequently for the identification of high and low relative risk (RR) clusters for a 5% significance level (using the Monte Carlo method). Space structure criteria were previously defined for the model by selecting (i) each municipality's centroid, ii) one circular window, iii) 20% of the total population as maximum dimension of each cluster, iv) time dimension of the clusters (2-32 years) and v) non-overlap municipalities in previously identified clusters.

The SaTScan software has been used for the space-time analysis and the results were mapped by using the ArcMap 10.5 software.

RESULTS

1. Evolution of the suicide rate between 1980 and 2015

A total of 31,131 suicide deaths occurred in Mainland Portugal over the study period, corresponding to a mean mortality rate of 8.8 per 100,000, with the lowest rate (5.1‰) found in 2000 and the highest in 2014 (11.7‰).

The analysis of the joinpoint regression model allowed for the identification of six periods of time with different variation trends in the suicide rate (Fig. 1): i) 1980-1984, mean annual 7.6% relative increase [95% Confidence Intervals (95% CI)]: 0.7; 15.0); ii) 1984-1995, mean 2.4% reduction (95% CI: -4.0; -0.8); iii) 1995-1999, mean 12.5% reduction (95% CI: -22.8; -0.8); iv) 1999-2002, mean 34.8% increase (95% CI: 5.3; 72.6); v) 2002-2006, mean 5.8% reduction (95% CI: -14.5; 3.8) and vi) 2006-2015, mean 2.6% increase (95% CI: 0.9; 4.4). Statistically significant trends were found in 1980 - 1984, 1984 - 1995, 1995 - 1999, 1999 - 2002 and 2006 - 2015.

2. Evolution of the suicide rate between 1980 and 2015

The space-time analysis of suicide rate allowed for the identification of five high-risk clusters, corresponding to 14,643 deaths (57%) and four low-risk clusters corresponding to 3,450 deaths (11%) (Fig. 2).

Municipalities from all the regions in Mainland Portugal were included into high-risk municipality clusters: i) municipalities from the Northeastern region of the country (Northern and Central regions) were included into cluster E; ii) those from the Central region were included into clusters D and B; iii) part of the municipalities of the Lisbon Metropolitan Area (*Área Metropolitana de Lisboa* - AML) were included into clusters C and A and iv) most of the municipalities from Alentejo and Algarve were included into cluster A.

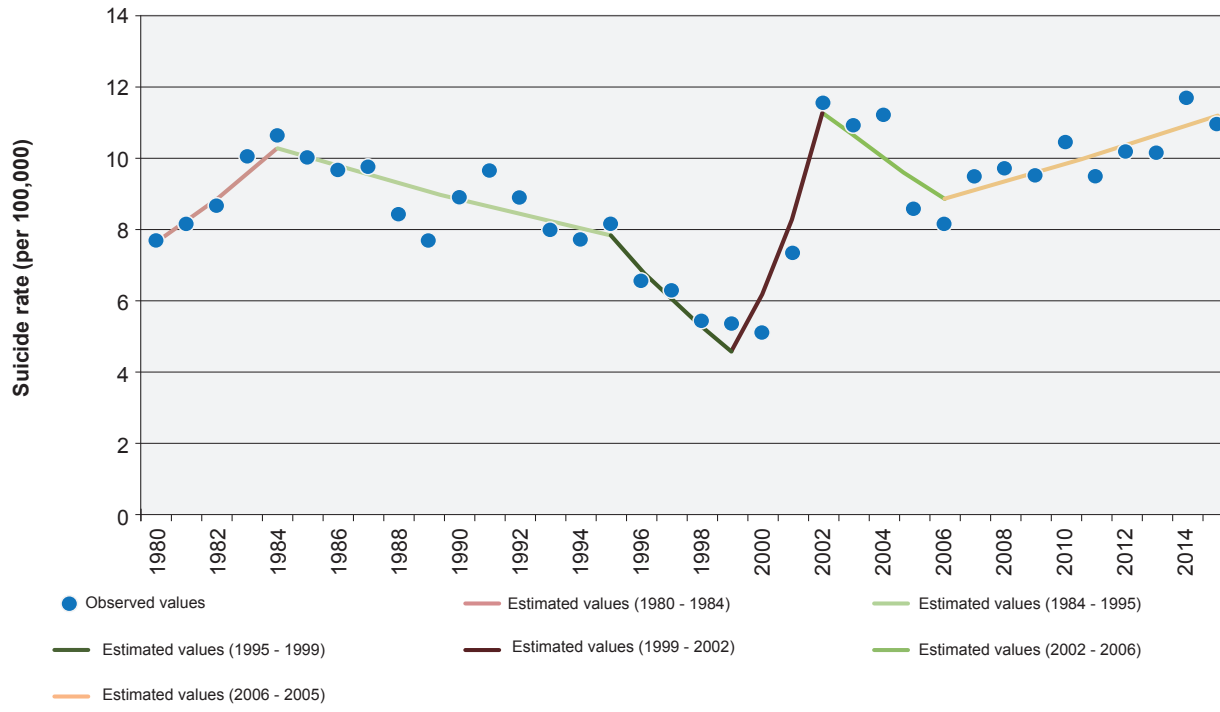

Figure 1 – Variation trends of suicide rate in Mainland Portugal between 1980 and 2015
Source: Own elaboration based on data from the INE, 2017

The longest duration (1982 - 2013) and the highest relative risk values were found in clusters A and B (cluster A: 2.54, cluster B: 2.17), with 19.1 and 18.2 per 100,000 suicide rates, respectively.

Clusters involving low-risk municipalities included those located in the Northern region (cluster F), Central (cluster H) and AML (clusters G and I). Cluster F showed the longest duration (between 1980 and 2011) and the lowest relative risk (0.28), with a 2.8 per 100,000 suicide rate (Table 1).

A changing trend has been found in Central and AML regions. Different municipalities included in cluster H (low risk, between 1989 and 2001) were moved to cluster D (high risk, 2002-2015). Conversely, part of the AML municipalities included in high-risk cluster C, 1985-1992, were moved to low-risk cluster I, 1996-2001.

The lowest population densities were found in high-risk clusters E and A (25 and 36 population per km^2, respectively). The highest population densities were found in clusters C (high risk), G and I (low risk): 2,398, 1,767 and 1,498 population per km^2, respectively.

DISCUSSION

This study was aimed at the analysis of the spatio-temporal evolution of suicide rate in Mainland Portugal (1980-2015) and the following results were obtained: i) significant increases in rate were found in three periods of time (1980 - 1984, 1999 - 2002 and 2006 - 2015) and significant reductions in two (1984 - 1995 and 1995 - 1999); ii) high relative risk of suicide has been found, ranging between 2.54 and 1.45 (in municipalities from Alentejo and Algarve between 1982 and 2013 and in municipalities from the Central region between 2002 and 2015, respectively) and iii) low relative risk of suicide has been found, ranging between 0.28 and 0.64 (in municipalities mostly from the Porto Metropolitan Area between 1980 and 2011 and in municipalities from the Greater Lisbon between 1996 and 2001, respectively).

The time trends in suicide rate that were found in the study, some of them in line with previous studies by Gusmão and Quintão,[46] may relate to periods of economic and financial stability/instability. A coincidence in time seemed to exist between the periods of increase in the suicidal phenomenon (1980 - 1984 and 2006 - 2015) with moments of economic and financial crisis and subsequent bailout received by Portugal from the International Monetary Fund (in 1977, 1983 and 2011). This relationship regarding Mainland Portugal was already found in the study by Santana *et al*.[33] Other authors also found an association between crisis and austerity contexts and an increase in suicide rate, based on the worsening of the world socioeconomic vulnerability,[27] in Europe,[26,29,32] in England,[14] in Finland,[28] in Greece,[30] and in the USA.[31]

Nevertheless, the 1999-2002 increase does not correspond to such a relationship, as it coincided with a period of economic prosperity before the financial crisis starting from 2008.[47] This significant increase in suicide rate may have been related to the effort carried out between 2002 and 2003 by the *Direção-Geral da Saúde* (DGS) aimed at an improved record/codification of suicide, which has led to an increase in the absolute number of deaths classified into the suicide category.[46]

Two patterns of the risk of suicide have been found, as regards space-time clusters. Significantly high suicide rates

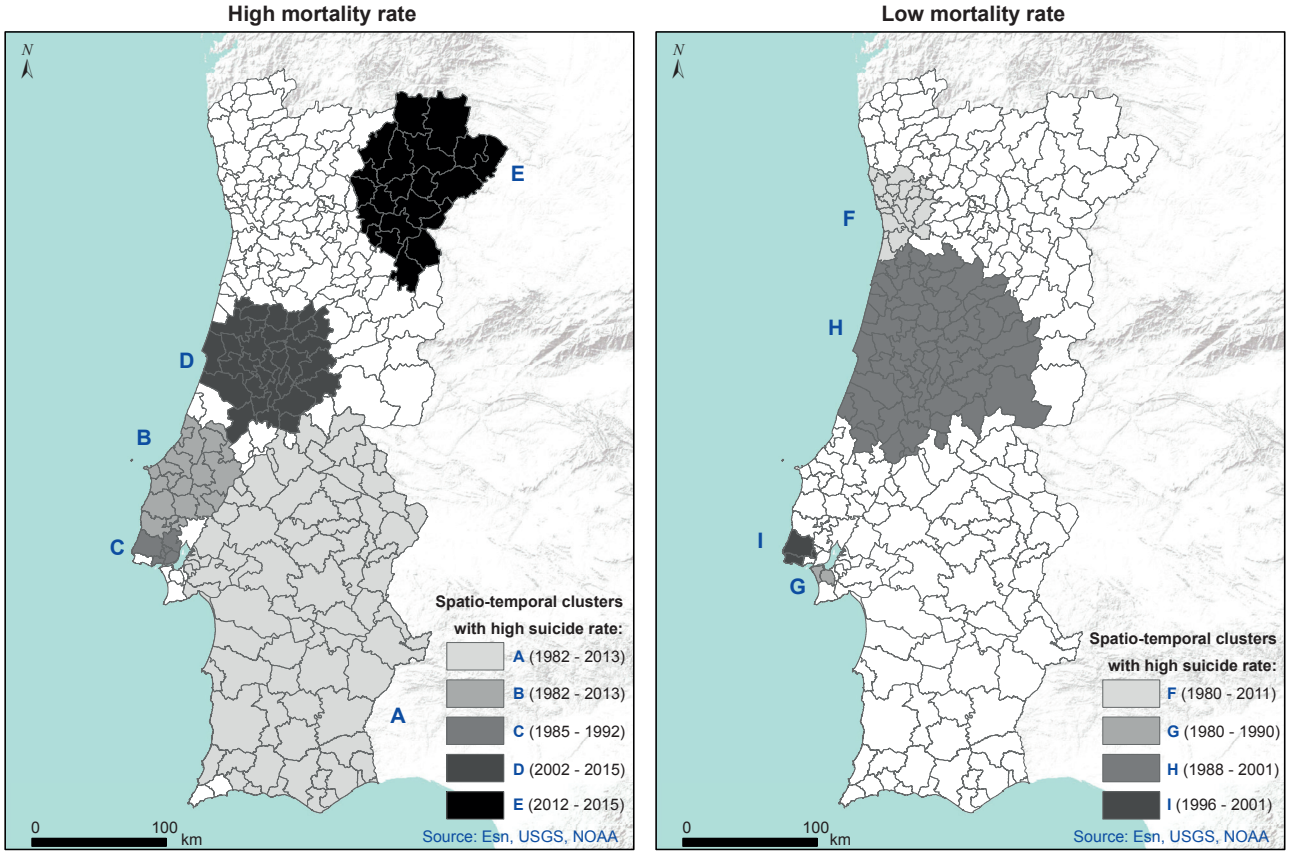

Figura 2 – Spatio-temporal clusters of suicide rate
Source: Own elaboration based on data from the INE, 2017

have been found nearly along the whole study period in the Southern region of Portugal, in line with the space patterning of the suicidal phenomenon that traditionally opposed the South (with high rates) to the North (with low rates).[33,48] However, the space-time analysis allowed for the identification of a change in space patterning: the highest risk of suicide has been found in the municipalities south of the river Tagus (cluster A, RR = 2.54) and in those from the Western region (cluster B, RR = 2.17), including some municipalities from AML (cluster C, RR = 1.61) over the first half of the study period (the eighties and the nineties overall); suicide rate was significantly high in a group of municipalities from the Central (cluster D, RR = 1.45) and the Northeastern region (cluster E, RR = 1.67), mainly in a group of municipalities from the Central region having moved from a low-risk (cluster H, 1988-2001, RR = 0.58) to a high-risk cluster (cluster D, 2002-2015, RR = 1.45), on the second half of this time interval (1998 - 2015). These results were in line with what is already known; high hospital admission rates due to mental disorders were already found in municipalities from

Table 1 – Spatio-temporal clusters of suicide rate

	Cluster	No. of municipalities	Area (km^2)	Period of time (years)	Population density (pop./km2)	Relative risk	*p*-value	Mortality rate per cluster per period (per 100,000)
High-risk (RR > 1)	A	76	37,631	1982 - 2013	36	2.54	< 0.001	19.1
	B	20	4258	1982 - 2013	133	2.17	< 0.001	18.2
	C	6	669	1985 - 1992	2,398	1.61	< 0.001	14.1
	D	33	7,792	2002 - 2015	90	1.45	< 0.001	12.8
	E	21	9,711	2012 - 2015	25	1.67	0.028	14.9
Low-risk (RR < 1)	F	21	2,272	1980 - 2011	845	0.28	< 0.001	2.8
	G	2	165	1980 - 1990	1,767	0.58	< 0.001	5.2
	H	69	17,472	1988 - 2001	104	0.58	< 0.001	5.3
	I	3	440	1996 - 2001	1,498	0.64	< 0.001	5.7

RR: relative risk

cluster D (within the Central region).[49]

The results mainly suggested that the geographical pattern of suicide rate has changed in 35 years: the Central and the Northern regions showed rates more similar to those traditionally found in the Southern region. Even though a possible variation regarding the under-notification of records of suicide in space and in time may have masked or increased some space-time patterning,[44] the present results are in line with previous studies.[33]

Space-time patterns support the ruralisation of the suicidal phenomenon,[33] considering i) the high-risk suicide clusters trend towards lower population densities when compared to low-risk clusters, ii) the clusterisation of municipalities with higher rurality and higher suicide rate (clusters D and E) and conversely iii) the identification of municipalities within the AML having moved to significantly lower suicide rates (cluster I). This trend may be linked to social determinants with an impact on these populations, i.e. a concentration of high-risk municipalities in rural areas, with low population density, ageing and showing weak economic and social dynamics.[33–35] Suicidal ideation and behaviour are enhanced by factors such as social and geographic isolation,[18,33,50,51] the lack of socioeconomic dynamics[33,52,53] and lower access to goods and services, namely to healthcare and social support.[18,20,33,53] In addition, greater mental-illness related stigma and easier access to lethal means are traditionally found in rural territories.[53,54] In times of economic and financial crisis rural areas seem even more vulnerable and less resilient considering its ageing social structure and mono-functional economic structure.[47]

Limitations

This study has some limitations associated to the baseline information, namely regarding the under-notification of suicide that may have been worse in the Northern region and throughout the initial years of the study.[46,55] A 6.5% percentage of total deaths were reported in 2015 as with undefined symptoms, signs and causes of death, according to the INE (*INE - Óbitos por causas de morte, 2017*), compared to an 11.8% percentage found in 1990 (*INE - Óbitos por causas de morte, 2017*), showing that, despite the efforts aimed at improving the codification of causes of death, in total and regarding suicide,[56] mainly regarding the validation of death certificates by the DGS in 2002 - 2003,[46] suicide remains under-represented.[46]

CONCLUSION

The spatio-temporal pattern of suicide has changed from 1980 to 2015, currently showing an increasing trend (from 2006) and higher risk in rural territories (municipalities within the regions of Alentejo, Algarve, Central region and in *Trás-os-Montes*).

The knowledge obtained with this study will help and explain for the implementation of actions aimed at these territories (based on their characteristics) and at the prevention of suicide. Monitoring the mental health of the Portuguese population is a relevant recommendation of the National Programme for Mental Health (*Programa Nacional para a Saúde Mental*),[57] which has been developed within the National Health Plan (*Plano Nacional de Saúde*). The best knowledge on the suicidal phenomenon as a key element for the prevention of suicide has been presented by the National Plan for the Prevention of Suicide (*Plano Nacional de Prevenção do Suicídio 2013 – 2017*),[56] aimed at i) a higher collective awareness, ii) the reduction of the stigma associated to suicide, iii) the definition of more adequate prevention strategies and iv) monitoring of the plan efficacy.

The identification and monitoring of space clusters over time will allow for a differentiated and interconnected action of the institutions and resources in high-risk areas for suicide, aimed at reducing iniquities, particularly under a crisis context, through i) the promotion and implementation of local well-being and mental healthcare actions and prevention of suicide (including the identification, treatment and rehabilitation of mental disorders), ii) the decentralisation and linkage between specialised healthcare in mental health with primary healthcare allowing for greater proximity of healthcare providers with an easier access and iii) the reinforcement of the social measures and supports that could help in reverting crisis situations.

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HUMAN AND ANIMAL PROTECTION

The authors declare that the followed procedures were according to regulations established by the Ethics and Clinical Research Committee and according to the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

CONFLICTS OF INTEREST

The authors declare that there were no conflicts of interest in writing this manuscript.

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