Regional suicide rates in the Netherlands: does religion still play a role?

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Background This study examined the nature of ecological associations between 'religiousness' and suicide rates (1985-1994) in the 11 provinces in the Netherlands.

Methods Indices of religiousness, obtained from a nationwide survey, were used as aggregate predictors of provincial suicide rates in weighted linear regressions, and as individual-level predictors of suicide acceptance in logistic regressions. Sociodemographic confounding was controlled for.

Results Orthodox beliefs and religious affiliation were the best predictors of lower suicide acceptance in individuals and of lower suicide rates in provinces. The ecological association was most pronounced in the least religious parts of the country giving rise to a curvilinear ecological regression line.

Conclusions Curvilinear ecological regression lines arise when mean levels of exposure affect individual risk above and beyond personal exposure i.e. when there is ecological effect modification. This study demonstrates that such contextual effects, responsible for cross-level bias, apply to the association between suicide and religiousness. Variation, from context to context, of the effects of exposure to psychosocial risk or protective factors for outcomes such as suicide, has important implications for research and prevention.

Keywords Suicide, religion, ecological effect modification

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Despite much research into aggregate associations of suicide rates, understanding of geographical suicide variation remains limited. It is unclear why rates in countries such as the Netherlands or the UK, should be lower than those in Scandinavia. Large regional variations are even apparent within countries or cities. Explanations of suicide rate differences have focused on certification biases, socioeconomic variation, or differences in the levels to which religiousness, associated with increased social cohesion and rejection of suicide, has remained influential.

Most ecological studies in this field search for associations between aggregate risk factors and suicide rates, typified by straight ecological regression lines and regression coefficients fixed across the range of aggregate risk factors. Cross-level bias which normally precludes application of ecological findings to individuals, is reduced if the group mean of the exposure variable has no effect on the disease risk at the individual level, controlling for the individual's exposure, i.e. when there is no ecological effect modification. Some ecological studies in which this condition applied have indeed been used successfully to generate individual relative risks from ecological data. However, for psychosocial risk factors such as those studied in connection with suicide and related outcomes, this condition is unlikely to be met. For instance, the risk of suicidal behaviour associated with unemployment declines if unemployment rates increase. Relative risks in psychiatric epidemiology are likely to vary across different populations, contrary to common assumption in cancer epidemiology.

Hence, it is not far-fetched to hypothesize that the risk for suicidal behaviour in religious relative to non-religious individuals, will depend on mean levels of religiousness in their local context. Given such effect modification, changes of aggregate exposure levels will affect the final number of cases twofold, giving exponential rather than linear ecological associations. First, as in any ecological study, by shifting the numbers of exposed and unexposed people, and, second, by modifying their respective rates of the outcome. The exponential association will result in a curved ecological regression line. This has not been considered before in analyses of the association between religion (or other aggregate psychosocial risk factors) and suicide, and may explain the ongoing uncertainty over apparently simple questions such as whether suicide rates are related to aggregate levels of risk/protective factors such as religion or unemployment, or not.

This study's primary aim was to test the hypothesis that the ecological association between levels of religion and suicide rates is represented best by a curved line. The analysis used data for the Netherlands, a country where linear associations between regional levels of religious affiliation and suicide rates
have been reported. The epidemiology of Dutch suicide is interesting. First, contrary to what is observed elsewhere, rates are higher in rural than urban areas. Second, regional socio-economic variations are relatively small and death registration uniform across regions so that these are unlikely to account for regional gradients. This increases the likelihood that associations between religion and suicide rates, if present, can be made apparent.

Religion is a multidimensional phenomenon, and it remains debatable which aspects of it (if any) are most relevant for suicide. Some propose that adherence to religious beliefs may mitigate suicide risk by creating cognitive dissonance whilst others feel that increased social support associated with religious adherence may be more relevant. Given this uncertainty, the ecological analysis used a multidimensional summary index of religiousness as well as separate indices of religious affiliation, attendance and belief, obtained from a representative survey of Dutch adults. As a preamble, associations were examined—in individual survey members—between religious variables and suicide acceptance, an outcome which is associated with suicidal behaviour at the individual and the aggregate level. Confounding by sociodemographic variables such as unemployment, education and urbanization levels was adjusted for.

Methods
Predictor and outcome variables
1) Individual-level variables
Individual-level variables were obtained from the SOCON dataset which is based on structured interviews of 3003 Dutch residents, aged 18 and over (1985). This survey, using a two-stage, stratified probability sampling, explored religion’s social relevance. From the four main geographical regions, respondents were selected with probability proportionate to urbanization levels. Refusal (40%) was unrelated to the sampling variables. The following variables were selected for analysis.

Socio-demographic: gender, age (divided in 18–39, 40–79, >80), living arrangement (alone or not), children (yes versus no), social class (ten levels from agricultural to senior professionals), educational (seven levels from primary school only to university degree), employment (unemployed and seeking work versus all other) and urbanization levels (11 increasing levels). Respondents’ province of residence (total N = 11) was obtained: a recently established, sparsely populated twelfth province of the Netherlands (previously a lake) was not included in the SOCON survey and is not considered further in this analysis.

Religious and attitudinal: church attendance (four frequency levels) and membership (none, Roman Catholic, liberal Protestant, Calvinist). The individual level outcome variable suicide acceptance was obtained from responses to ‘Do you think people should have the right to kill themselves if they want to?’ with answers, ‘yes’, ‘in some circumstances’, ‘no’.

Composite variables: principal components (PC) analysis was used to assign survey members scores for permissiveness, salience of belief and orthodoxy. The permissiveness score was based on responses to questions (phrased like the suicide acceptance item) concerning acceptability of family planning, abortion and euthanasia, and accounted for 44% of total item variability. The salience score was based on five questions concerning traditional Christian beliefs and accounted for 83% of total item variability (Appendix A).

2) Suicide counts
Annual suicide counts by province, gender and age group (<39, 40–79 and >80) for the years from 1985–1994, and population counts similarly aggregated, were obtained from the Dutch Central Bureau of Statistics. For each province, gender and age-specific suicide rates were calculated as well as a crude rate aggregated over genders, age groups and years.

3) Ecological indicators
Sociodemographic indicators: at province level these were obtained for 1986 (percentage of population living in rural communities, with tertiary education and unemployed).

Religious: provincial aggregate values for orthodoxy and salience were obtained by calculation of proportions of respondents in each province scoring above the respective national median values. Provincial aggregate values for religious attendance and affiliation were expressed as proportions of respondents attending at least weekly, and indicating any affiliation respectively.

Analysis
Suicide acceptability in individuals
Logistic regression was used to compare characteristics between respondents indicating unconditional acceptance of suicide (N = 794) and those who indicated unconditional or conditional rejection of suicide (N = 2106). Levels of permissiveness were controlled for in order to isolate attitudes toward suicide from a general moral stance. Continuous and ordered predictor variables were standardized to the entire dataset so that odds ratios (OR) approximate the relative risk for suicide acceptance associated with one standard deviation’s shift on the independent variables.

Ecological associations of suicide rates
The ecological analysis proceeded as follows. First, linear regression was specified for the association of the separate religious variables with untransformed and logarithmically transformed (natural logarithm) crude rates as respective outcomes in order to assess which of these provided a better fit indicated by the squared variance. The best performing outcome was subsequently used. Second, religious and sociodemographic summary scores were calculated for the 11 provinces, based upon multiple regressions of crude suicide rates on the four religious and the three sociodemographic variables. Third, associations between crude suicide rates and the separate summary regression scores were weighted for provinces’ population sizes. Fourth, the fit of curved (achieved by exponential transformation of the summary scores) and linear (untransformed summary scores) regression lines were compared; the best performing transformations were used in subsequent analyses of the association between age- and gender-specific suicide rates with religiousness in the provinces. In these analyses, six rates (two genders, three ages)
and sociodemographic summary scores were calculated for each and the three sociodemographic variables respectively, religious scores

Summary score

Religious: $R^2 = 40.6\%$ versus $40.3\%$). The outcome in all subsequent analyses is the natural logarithm of suicide rates.

Crude suicide rates were inversely associated with each of the religious variables, the effect being strongest for orthodoxy and church membership. No associations were apparent between crude suicide rates and sociodemographic variables. Based on multiple regressions of crude suicide rates on the four religious, and the three sociodemographic variables respectively, religious and sociodemographic summary scores were calculated for each province. These accounted, after weighting for population sizes, for $48.4\%$ and $10.8\%$ of crude rate variation respectively. Exponential transformation of the religious summary score increased the explained rate variation to $59.2\%$ maximally and was used further, giving a curved regression line (Figure 1). The fit of the regression of suicide rates on the sociodemographic summary score could not similarly be improved so that this variable was retained in untransformed form (Table 2).

The association between crude suicide rates and the (transformed) religious summary score was strongly negative irrespective of adjustment for sociodemographic confounding (Table 3).

**Results**

**Suicide acceptance in individuals**

Decreased suicide acceptance was associated with lower levels of permissiveness and higher levels of salience, orthodoxy, church attendance and religious affiliation, strongest for Calvinist congregations. Increased suicide acceptance was associated with younger age, urban residence, unemployed, single and childless status. Orthodoxy, permissiveness, church membership, socioeconomic and educational status contributed to a multivariate model for suicide acceptance which did not perform worse than the full model (Table 1).

**Ecological associations of suicide rates**

**Rate transformation**

Regressions of aggregate religious variables with the logarithm of crude suicide rates as outcome performed marginally better than those containing the untransformed outcome (e.g. orthodoxy: $R^2 = 40.6\%$ versus $40.3\%$). The outcome in all subsequent analyses is the natural logarithm of suicide rates.

**Summary scores**

Crude suicide rates were inversely associated with each of the religious variables, the effect being strongest for orthodoxy and church membership. No associations were apparent between crude suicide rates and sociodemographic variables. Based on multiple regressions of crude suicide rates on the four religious, and the three sociodemographic variables respectively, religious and sociodemographic summary scores were calculated for each province. These accounted, after weighting for population sizes, for $48.4\%$ and $10.8\%$ of crude rate variation respectively. Exponential transformation of the religious summary score increased the explained rate variation to $59.2\%$ maximally and was used further, giving a curved regression line (Figure 1). The fit of the regression of suicide rates on the sociodemographic summary score could not similarly be improved so that this variable was retained in untransformed form (Table 2).

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**Age- and gender-specific associations**

After adjustment for age and gender (by specifying a model containing the religious summary score and dummy variables for gender and age group, and, as outcome the age- and gender-specific rates), the negative association between suicide rates and the religious summary score was stronger than in the unadjusted model, irrespective of sociodemographic confounding (Table 3). Associations of the religious summary score with suicide rates differed by age ($F[2,10] = 7.7; P = 0.009$) but not gender ($F[1,10] = 0.7; P = 0.435$). In the final model, adjusted for gender and stratified by age, significantly negative associations between suicide rates of the older and middle but not the younger age group, and the religious summary score were apparent. Adjustment for sociodemographic confounding slightly mitigated the association between religiousness and suicide rates in the older but strengthened it in the younger age group (Table 3).

**Discussion**

Suicide acceptance is lower among individuals who espouse religious beliefs than those who do not. Most of the sociodemographic associations of increased suicide acceptance such as unemployed, childless and single status are known risk factors for suicide itself. This raises the likely relevance of findings pertaining to suicide acceptance for actual suicidal behaviour. Adjustment for permissiveness did not remove the association.
Table 2  Ecological association of crude suicide rates with religious and sociodemographic variables

<table>
<thead>
<tr>
<th>Standardized religious variables</th>
<th>Sociodemographic variables</th>
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<tbody>
<tr>
<td>Orthodoxy</td>
<td>% Rural population</td>
</tr>
<tr>
<td>Salience</td>
<td>% Unemployed men</td>
</tr>
<tr>
<td>Church membership</td>
<td>% Higher educated</td>
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<td>Weekly attendance</td>
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</tbody>
</table>

All regression coefficients are multiplied by 1000 to improve legibility.

Table 3  Ecological association of suicide rates with religious and sociodemographic variables, adjusted for gender and age effects

<table>
<thead>
<tr>
<th>Unadjusted for age and gender (n = 11)</th>
<th>Adjusted for age and gender (n = 66)</th>
<th>Adjusted for gender, stratified by age(^a)(^b) (n = 66)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression coefficients; 95% confidence interval; P-value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-96.0 (-156.1, -35.9)</td>
<td>-153.4 (-230.4, -76.4)</td>
<td>0/39 -108.8 (-247.6, 30.1); P = 0.112</td>
</tr>
<tr>
<td>P = 0.006</td>
<td>P = 0.001</td>
<td>-158.8 (-278.1, -39.5); P = 0.014</td>
</tr>
<tr>
<td>-94.6 (-167.9, -24.2)</td>
<td>-132.0 (-222.2, -42.0)</td>
<td>40/79 -66.4 (-121.3, -11.4); P = 0.023</td>
</tr>
<tr>
<td>P = 0.015</td>
<td>P = 0.008</td>
<td>-46.0 (-102.0, 90.0); P = 0.202</td>
</tr>
</tbody>
</table>

R\(^2\) = 59.2%                        R\(^2\) = 79.6%                        R\(^2\) = 83.1% |
R\(^2\) = 59.2%                        R\(^2\) = 79.8%                        R\(^2\) = 83.3%

All regression coefficients are multiplied by 1000 to improve legibility.

In italics: estimates of regressions coefficients, P-values and squared variances after adjustment for the sociodemographic confounder.

a Interaction gender * religion score: F(1,10) = 0.7; P = 0.435.

Of orthodox religious beliefs and religious affiliation with suicide rejection, suggesting that this link is specific rather than merely reflective of low tolerance generally among the religious. Even in a secularized country such as the Netherlands, religiousness is apparently not immaterial to attitudes toward suicide. Given indications that suicide acceptance is associated with suicidal behaviour, at individual\(^24\) and aggregate levels,\(^25\) this provides a basis for the ecological study of associations between suicide rates and religiousness.

Suicide rejection was strongest among Calvinists. However, hyper-orthodox Calvinism may increase depression risk\(^31\)\(^32\) for instance by inculcating guilt\(^33\)\(^34\) over sins which cannot be repaired as they can in the Roman Catholic tradition. Religious hyper-orthodoxy is reportedly associated with maladjustment.\(^35\)

Despite strict suicide proscription within Calvinist groups, their suicide rates were, in the first half of this century, higher than those of Catholics, liberal Protestants and the non-affiliated.\(^5\) Absolute suicide rejection may originate in hyper-orthodoxy, itself a possible risk factor for depression and suicidal behaviour. Hence, reduced stated levels of suicide acceptance in individuals cannot straightforwardly be taken to indicate reduced suicide risk; more refined attitude measurements\(^36\) are needed to determine to what extent absolute suicide rejection reflects hyper-orthodoxy, and may therefore be associated with increased rather than decreased suicide risk.
more pronounced with levels of religious attendance. Hence, the results support Stack's view\textsuperscript{13} that, in post-modern societies, personal beliefs are at least as relevant as integration in religious institutions for the explanation of individual and group behaviour.

This analysis has some methodological advantages over comparable studies. Weighting was used to account for relative amounts of information contributed per province.\textsuperscript{28} The explained rate variance reduced as a result, suggesting that studies which have not used this adjustment must be interpreted cautiously.\textsuperscript{1,11-13} Contrary to comparable studies,\textsuperscript{9,12,13} a multiplicative model was specified (using logarithmically transformed rates) as this provided the best fit. The main aim being an examination of the shape of the regression line, summary religious and sociodemographic indices\textsuperscript{28} were used so that multi-collinearity could be avoided by reducing the number of covariates. The survey on which this analysis was based enquired about Christian beliefs only; with only 3.2% immigrants (first and later generations) in the survey,\textsuperscript{22} this is unlikely to have biased the associations found although their applicability to contexts with higher levels of non-Western religion will be limited.

There was no consistent association between suicide rates and sociodemographic regional characteristics, suggesting that ecological confounding is unlikely to have produced spurious religion-suicide associations. This supports the view that Dutch regional gradients in suicide mortality, which have been apparent for decades,\textsuperscript{3} are more likely to reflect geographical attitudinal than sociodemographic variation. Adjustment for gender and stratification by age indicated that the inverse association between religiousness and suicide rates was strongest for the elderly, replicating previous findings for the Netherlands\textsuperscript{12} and elsewhere.\textsuperscript{13}

A curved line best represented the macro-level association between religiousness (captured by the summary score) and suicide rates. Such curvilinearity most likely arises when there is ecological effect modification although confounding may also contribute.\textsuperscript{37} Given the virtual absence of sociodemographic confounding, the most plausible explanation for the curvilinearity is that the protection afforded by given individual levels of religiousness varies with the regional prevalence of religiousness. As the ecological regression line is based on the sum of cases irrespective of their religiousness, the direction of the curve (concave or convex) cannot be used to infer whether suicide rates among the religious and the non-religious respectively, rise or fall with increasing prevalence of religiousness. The results would be compatible with a dilution of protection when regional religious salience increases. However, the reverse is equally possible; concentration of protection may be associated with higher regional levels of religiousness.\textsuperscript{38}

Support for either of these propositions is available from individual-level research. Among Catholic minorities in the Protestant North of the Netherlands, suicide rates are lower than among Catholics in the Catholic South\textsuperscript{5}—the protective effect of Roman Catholic affiliation apparently is diluted when this affiliation becomes the rule. Conversely, church attendance reportedly protects more strongly against depression (a strong suicide risk factor\textsuperscript{3}) in areas with high (i.e. the Outer Hebrides) than in areas with low attendance (i.e. Inner London) rates\textsuperscript{39}—the protective effect of attendance becomes concentrated when it becomes more the norm. In highly religious regions (e.g. the Outer Hebrides), joining with the majority may increase social integration and thus buffer against depression, or, conversely, non-adaptation to prevalent norms may reflect pre-existent vulnerabilities.\textsuperscript{25,39,40} However, in less religious populations (e.g. the Netherlands) where religious belief may be more a matter of individual choice than tradition, protective effects arising from the close social support and mutually shared conviction in smaller, more closely-knit (religious) communities\textsuperscript{41,42} may override the negative consequences of minority status.\textsuperscript{40} The net effect of ecological effect modification (concentration or dilution of risk or protection) and hence the direction of the ecological curve, will depend on the nature of the risk factor studied, the size of the units of analysis,\textsuperscript{9} and crucially, the range of exposure levels available for examination.

It is concluded that in a country such as the Netherlands where sociodemographic differences between regions are small, suicide rate variations remain associated with regional religious differences. The continuing relevance of religious variables in connection with suicidal behaviour is further emphasized by the negative associations between suicide acceptance and religious belief. Ecological associations between religion and suicide may be weaker in countries with stronger sociodemographic regional differences; this would be a worthwhile area for further study.

This paper's main message concerns the phenomenon of ecological effect modification: future epidemiological studies of suicide (and related outcomes) should consider that the magnitude of relative risks associated with exposure to psychosocial risk (or protective) factors depends, in all likelihood, on the prevalence of these factors themselves in study populations. The likely variation of relative risk(s) as a function of the contextual distribution of the risk factor demonstrates an important but neglected principle: changes in the prevalence of risk factors in communities (for instance as a result of public health efforts) may result, not only in shifting community rates of the outcome but also in increased risk in the most vulnerable.\textsuperscript{38} Thus, attempts to improve public health by modifying the prevalence of risk or protective factors, may bring about unwanted increase of risk in traditionally protected groups and hence harvest less gain than anticipated.

Appendix A
Permissiveness

'A married couple chooses to have no children even though there is no medical reason why they shouldn't. Can you accept such an attitude or do you find it unacceptable?'

'Do you think it should be possible for a woman to have an abortion without further preface if she wants to?'

'Imagine a doctor can put a patient out of his pain at his own request by administering an injection. According to you should he do it or not?'

'According to you, are there circumstances in which abortion, i.e. deliberate interruption of pregnancy, should be permitted?'

Principal component: 44.1% of the variance.
Orthodoxy
'There is a God who occupies himself with every human being personally.'

'God wants to be God for us.'

'God revealed himself in Jesus Christ.'

'God's Kingdom will come.'

Principal component: 83.2% of the variance.

Salience
'My religion has much influence on my daily life.'

'My religion plays a major part when I have to make important decisions.'

'My religion has much influence on my political ideas.'

'My life would be different without my religion.'

'My religion is something I am very interested in.'

Principal component: 70.2% of the variance.

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