

1 **'HOLY ANOREXIA' – RELEVANT OR RELIC? RELIGIOSITY AND**
2 **ANOREXIA NERVOSA AMONG FINNISH WOMEN**

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ABSTRACT

Objective: Since medieval times, an association between religiosity and anorexia nervosa has been suggested, but few systematic studies exist. We studied in a nationwide setting whether personal or family religiosity is associated with lifetime anorexia nervosa among women in adolescence and early adulthood.

Method: In this nationwide study we screened women (N=2,825) from the 1975–79 birth cohorts of Finnish twins for lifetime DSM-5 anorexia nervosa (N=92).

Parental religiosity was assessed by self-report when the women were aged 16 years. The women self-reported their religiosity at ages 16 and 22–27 years.

Results: Parental religiosity did not increase the risk of lifetime anorexia nervosa, and neither did religiosity of the women themselves in adolescence. In early adulthood, a J-shaped curve was compatible with the data, indicating increased risk both at low and high levels of religiosity, but this result was statistically non-significant. Religiosity was weakly negatively correlated with body

dissatisfaction. We also found suggestive evidence for socioregional variation in the association of religiosity with lifetime anorexia nervosa. **Discussion:** To our

knowledge, this is the first population study to directly address religiosity and anorexia nervosa. We found no evidence for a significant association of

religiosity with anorexia nervosa, either at the personal or family level, although we could not exclude regional differences nor a modest protective association of

religiosity with body dissatisfaction. Despite compelling case descriptions of

‘holy anorexia’, religiosity does not appear to be a central factor in the

development of anorexia nervosa in Finland, a highly secularized Christian

country.

1 **'HOLY ANOREXIA' – RELEVANT OR RELIC?**

2

3 Religiosity has been associated with various forms of fasting and self-
4 starvation for thousands of years. The founder of Jainism fasted himself to death
5 in the 6th century BC, and Moses, Buddha, and Jesus fasted in key moments of
6 their life^{1,2}. Many early Christian saints and hermits abstained from eating as a
7 part of ascetic-mystic practices¹.

8

9 From the 13th century, a wave of religiously motivated self-starvation
10 swept through Europe³⁻⁶. This resulted in at least 100 documented cases of 'holy
11 anorexia' among Italian holy women⁵. The patron saint of Italy, Catherine of
12 Siena, was the most famous example of religiously motivated self-starvation³⁻⁵.

13

14 From the beginning, 'holy anorexia' gave rise to various interpretations.
15 Self-starvation was occasionally even interpreted as a sign of demonic
16 possession⁵. Gradually, the practice of religiously motivated self-starvation
17 declined^{5,7}. In the 18th and 19th centuries, claims of miraculous self-starvation
18 were often met with skepticism, because fasting was sometimes practiced for
19 monetary gain and notoriety^{1,8}. In 1873, the era of modern anorexia nervosa

1 began, as the syndrome was described almost simultaneously by Lasègue and
2 Gull⁹.

3

4 The intriguing historical accounts of anorexia-like symptoms among
5 extremely religious women present the question whether 'holy anorexia' and
6 anorexia nervosa are continuous phenomena^{3,4,7}. They also imply a possible
7 etiological connection between religious beliefs and practices and eating
8 disorders. Putative causal mechanisms could be intrinsic, involving religiously
9 motivated ascetic behaviors, or they could involve religiously motivated societal
10 or family level constraints.

11

12 The potential role of individual-level religiosity in the onset of anorexia
13 nervosa and anorexia-like syndromes is suggested by a large number of modern
14 case studies. They demonstrate that 'holy anorexia' is not limited to past
15 centuries: religious fasting can still trigger symptoms that resemble anorexia
16 nervosa^{10,11}. The contexts are diverse, ranging from schoolgirls fasting for
17 religious motives in Ghana¹² to nuns in Catholic convents^{11,13}, and do not seem
18 specific to any particular religion^{10,13-18}.

19

1 Many authors have suggested that the clash between young women
2 adopting Western values and their traditional, religiously conservative families
3 can increase eating disorders^{19,20}. For example, among Asians living in the United
4 Kingdom, such tensions appeared to predispose young women to eating
5 disorders²¹. However, these studies tend to confound religiosity and culture,
6 because they arise from settings where the religiously conservative group is also
7 an ethnic minority. For example, in Canada, adolescent girls from the Jewish
8 minority had more disordered eating than non-Jewish girls, but the level of
9 religious observance was not associated with eating symptomatology¹⁶.

10

11 Although religiosity can plausibly be seen as a risk factor for anorexia
12 nervosa, some studies have found no associations^{22,23}, and many recent studies
13 have even found inverse, protective associations. A widely held view is that
14 Western sociocultural pressure to be thin is a key risk factor of eating
15 disorders^{19,24-27}. Religiosity can alleviate this pressure^{24,28} by providing a protected
16 environment²⁹ and a community of support²⁸. Personal religiosity can protect
17 from body dissatisfaction²⁴, provide additional coping strategies³⁰ and mitigate
18 the negative mental health effects of eating disorders³¹. Further, the motives of
19 personal religiosity may be significant³²⁻³⁴.

20

1 In summary, a plethora of case studies suggest a potential connection
2 between religiosity and anorexia nervosa, and family religiosity, particularly
3 among immigrants and religious minorities, may also contribute to eating
4 disorder symptoms. On the other hand, some recent evidence contradicts these
5 connections. The existing population studies do not directly address the
6 association of religiosity with anorexia nervosa^{31,35}. Therefore, our aim was to
7 study in a nationwide setting whether personal or family religiosity is associated
8 with lifetime anorexia nervosa among women in adolescence and early
9 adulthood.

10

11

METHODS

12

FinnTwin16 birth cohorts

14 This nationwide longitudinal cohort study of twins and their families³⁶
15 identified twin births in 1975–79 from the central population register of Finland.
16 The FinnTwin16 cohort was restricted only to those pairs who both were alive at
17 age 16 years and resident in Finland. Data collection and analysis were approved
18 by the ethics committee of the Department of Public Health of University of
19 Helsinki and by the Institutional Review Board (IRB) of Indiana University.

20

1 The families of the twins were approached when the twins had reached 16
2 years (wave 1). A returned family questionnaire implied informed consent and
3 prompted the sending of baseline self-report questionnaires with an assessment
4 of religiosity. Follow-up questionnaires were mailed to the twins when they were
5 17 years (wave 2), 18 years (wave 3), 22–27 years (wave 4) and finally 31–37 years
6 (wave 5). Wave 4 also included an assessment of religiosity and a screen for
7 eating disorders. The analyses in the present paper are based on female twins
8 and their parents in waves 1 and 4 (Figure 1).

9

10 **Religiosity in parents and adolescent women** (age 16 years) was
11 measured using the 12-item Religious Fundamentalism content scale of the
12 Minnesota Multiphasic Personality Inventory (MMPI)^{37,38} (Appendix A) that
13 measures religiously motivated behaviors and religious beliefs emphasizing
14 Christian tenets. The scores ranged from 0 to 12 and were roughly normally
15 distributed although the father's scores were skewed to the right; higher scores
16 reflected higher religiosity. The Cronbach's α was 0.82 for mothers, 0.85 for
17 fathers and 0.82 for adolescent women.

18

19 **Religiosity in early adulthood** (age 22–27 years) was self-reported using
20 the following multiple-choice item: "How important do you think religion is in

1 your life?" 1) Very important, 2) important, 3) not very important, 4) not at all
2 important, 5) cannot tell. Because the first and last categories evoked few
3 responses, categories 1 and 2 were merged and responses to category 5 were
4 considered missing information. The resulting categorical variable ("religious",
5 "not very religious", and "not at all religious") was moderately correlated with
6 religiosity in adolescence (Kendall's tau-b = 0.41). The auxiliary religiosity
7 variables, an aggregate measure of religiosity and formation of tertiles of
8 religiosity are explained in Appendix B.

9

10 Eating disorder symptoms and diagnoses

11 In early adulthood (at age 22–27 years, mean 24.5, SD 0.9), 2,825 women
12 (87% of the original cohort) completed a self-report screen for eating disorder
13 symptoms^{39,40}. The screen included the three subscales of the Eating Disorder
14 Inventory 2 (EDI-2)⁴¹: Bulimia, Body Dissatisfaction and Drive for Thinness.
15 (Cronbach's α s in our female sample 0.83, 0.92 and 0.87, respectively). All screen-
16 positive women (N=292), their female co-twins (N=130), and 210 randomly
17 selected women were invited to participate in diagnostic telephone interviews
18 conducted using the Structured Clinical Interview for DSM-IV (SCID)⁴². Four
19 MDs and one registered nurse from the Eating Disorder Unit of Helsinki
20 University Central Hospital interviewed 86.7% of the eligible participants^{39,40}.

1 After the publication of the Diagnostic and Statistical Manual of Mental
2 Disorders, Fifth Edition (DSM-5) in 2013, four experienced MDs recoded the
3 interviews and established consensus DSM-5 eating disorder diagnoses. Age of
4 onset of symptoms and recovery status were also determined on the basis of the
5 interviews^{43,44}.

6

7 In total, 92 women fulfilled DSM-5 criteria for lifetime anorexia nervosa.
8 Women who were not diagnosed with any eating disorder and who did not have
9 a twin sister with an eating disorder were considered healthy women (N=2,556).
10 Five of the women with lifetime anorexia nervosa were among the 180 randomly
11 selected women who were interviewed. Therefore, there most likely were some
12 women with undetected anorexia nervosa among those considered healthy.

13

14 **Education and place of residence** were considered as potential
15 confounders and effect modifiers^{38,45,46}. Education in early adulthood was
16 analyzed in two categories: non-academic education (compulsory education only
17 or vocational secondary education) vs. academic education (academic secondary
18 education (high-school) or tertiary education (college, university)).

19

1 Place of residence in adolescence was available from the last year of wave
2 1⁴⁷ and was divided into Southern Finland and Northern Finland^{38,48}. Southern
3 Finland is less religious and more densely populated than Northern Finland³⁸,
4 but both urban and rural areas exist both in Southern and Northern Finland.
5 Place of residence in early adulthood was available from self-reports, and was
6 analyzed in two categories: 1) urban areas (capital area and cities with at least
7 20,000 inhabitants) and 2) rural areas (including small towns).

8

9 Datasets and multiple imputation

10 A detailed description of the datasets and the multiple imputation process
11 can be found in Appendix B. In short, because our data consists of twins, we
12 divided each twin pair to two separate datasets (dataset A and dataset B). After
13 exclusion of women with missing information on anorexia nervosa status and the
14 few women living on the Åland Islands³⁸, dataset A consisted of 1312 women of
15 whom 38 were affected by lifetime DSM-5 anorexia nervosa, and dataset B
16 consisted of 1327 women of whom 53 were affected by lifetime DSM-5 anorexia
17 nervosa.

18

19 We used substantive-model compatible fully conditional specification
20 (SMC-FCS) multiple imputation to impute missing covariates for main

1 analyses^{49,50}. A separate substantive model, and thus a separate multiple
2 imputation, was used for the analyses where the outcome was restricted to DSM-
3 5 anorexia nervosa with age of onset >16 years. Additional analyses concerning
4 currently symptomatic women, place of residence in early adulthood and EDI-2
5 subscales in early adulthood were based on complete cases after stepwise
6 deletion in datasets A and B because of sparse data or limited number of
7 substantive models supported by the SMC-FCS multiple imputation statistical
8 package. However, there were few missing values in these variables.

9

10 Statistical analysis

11 We used logistic regression to model the relationship between religiosity
12 and anorexia nervosa. We combined the point estimates and their 95%
13 confidence intervals across imputations using Rubin's rules^{51,52}. We repeated the
14 same analyses separately in both datasets to see if our results can be replicated.
15 Further, we used Kendall's tau-b and Spearman's rank correlation coefficients to
16 assess correlations, linear regression to compare means, and multinomial logistic
17 regression to assess change in religiosity (Appendix B). We used the statistical
18 software package Stata 13 in all analyses, and all p-values and confidence
19 intervals are two-sided. The p-values are rounded upwards.

20

1

RESULTS

2

3 Parental religiosity

4 Overall, mothers were more religious than fathers ($p < 0.001$ in both
5 datasets, Table 1). Neither high religiosity of mothers nor high religiosity of
6 fathers predicted lifetime DSM-5 anorexia nervosa among their daughters
7 (Figure 2).

8

9 We also tested the joint effect of the religiosity of both parents by
10 comparing families where both parents were in the highest tertile of religiosity to
11 families where both parents were in the lowest tertile of religiosity. Yet, we
12 found no evidence for an increased risk of anorexia nervosa among the
13 daughters of the most religious families (results not shown).

14

15 Personal religiosity in adolescence

16 Religiosity in adolescence was not associated with lifetime DSM-5
17 anorexia nervosa (Figure 2). To gain a prospective perspective, we restricted the
18 analyses to women whose symptoms of anorexia nervosa appeared after the
19 baseline measurement of religiosity at age 16 years; the odds ratios increased a

1 little, but no evidence for an increased future risk of DSM-5 anorexia nervosa
2 associated with religiosity was found (Figure 2).

3

4 To assess the effects of very high religiosity, we also contrasted the most
5 religious decile to the rest of the women. The odds ratios for lifetime DSM-5
6 anorexia nervosa for the most religious decile were 0.62 (95% confidence interval
7 (CI) 0.09-4.26) and 0.36 (95% CI 0.05-2.45) in Datasets A and B, respectively.

8

9 Personal religiosity in early adulthood

10 Personal religiosity in early adulthood (age 22–27 years) had a J-shaped
11 association with lifetime DSM-5 anorexia nervosa, but this finding was not
12 statistically significant (Figure 3). Adjustment for education (non-academic vs.
13 academic) left these results virtually unchanged.

14

15 To reduce the potential impact of retrospective diagnostic assessment, we
16 conducted a subgroup analysis contrasting *currently symptomatic women* with
17 healthy women. The results suggest that currently symptomatic women may be
18 less religious than healthy women (Appendix C). In comparison to healthy
19 women, those who were currently symptomatic in early adulthood had lower

1 religiosity already in adolescence, but the estimates were imprecise (Appendix
2 D).

3

4 Eating Disorder Inventory 2 in early adulthood

5 We assessed the cross-sectional association of religiosity with eating
6 disorder symptoms (as measured by the EDI-2) in early adulthood. In dataset A,
7 the Spearman's rank correlation coefficient between religiosity and Bulimia was
8 0.010 ($p=0.73$), religiosity and Drive for Thinness 0.0083 ($p=0.78$), and religiosity
9 and Body Dissatisfaction -0.082 ($p=0.005$). In dataset B, the Spearman's rank
10 correlation coefficients were: religiosity and Bulimia -0.011 ($p=0.70$), religiosity
11 and Drive for Thinness 0.0025 ($p=0.94$), and religiosity and Body Dissatisfaction
12 -0.054 ($p=0.06$).

13

14 Socioregional differences

15 We studied interactions with areas of residence. *In wave 1*, we contrasted
16 Northern Finland with Southern Finland to see whether a more religious cultural
17 environment changed the relationship between parental religiosity and offspring
18 anorexia nervosa. These analyses yielded suggestive evidence for socioregional
19 differences in the association of paternal and maternal religiosity with the risk of
20 anorexia nervosa (Appendix E).

1

2 *In adolescence*, personal religiosity was not associated with anorexia
3 nervosa in either Northern or Southern Finland (Appendix E). *In early adulthood*,
4 however, we found that in rural areas of Finland, 70% of women with lifetime
5 DSM-5 anorexia nervosa were religious; none of them were not at all religious.
6 This finding was in contrast to the urban areas, where the results were
7 comparable to the main analysis: a J-shaped association was observed (Appendix
8 F).

9

10 **DISCUSSION**

11

12 Compelling medieval descriptions of ‘holy anorexia’ and many modern
13 case studies of religious fasting suggest an etiological connection between
14 religiosity and anorexia nervosa, but few systematic studies have examined this
15 question in the population. We conducted a nationwide study to assess the
16 connection between personal and family religiosity and lifetime DSM-5 anorexia
17 nervosa and eating disorder symptoms among women in a highly secular
18 context of present-day Finland, where our measures of religiosity mainly
19 reflected Christian religion. Our study found no evidence that either higher

1 personal or parental religiosity is significantly associated with lifetime anorexia
2 nervosa in our population-based Finnish twin cohort.

3

4 The association of religiosity in early adulthood with lifetime DSM-5
5 anorexia nervosa showed a J-shaped curve. However, this finding was not
6 statistically significant, and when we analyzed the risk of lifetime anorexia
7 nervosa by tertiles of religiosity in early adulthood, the J-shaped curve was not
8 replicated (Appendix G). Religiosity in adolescence did not increase the risk of
9 lifetime DSM-5 anorexia nervosa. Nor did religiosity in adolescence increase the
10 risk of anorexia nervosa onset in the future. Further, of the subscales of the
11 Eating Disorder Inventory 2, Bulimia and Drive for Thinness were not correlated
12 with religiosity in early adulthood, and Body Dissatisfaction had rather a
13 negative than a positive correlation with religiosity. Combining these evidence,
14 personal religiosity does not seem to increase the risk of anorexia nervosa.

15

16 Our findings do not contradict the few modern population studies
17 conducted to date. Religiosity and eating disorder symptoms were not directly
18 associated in Canada³⁵, whereas a large USA-based study found that religiosity
19 might have a beneficial effect on mental health: religious attendance and prayer
20 mitigated the negative effects of eating disorders on self-esteem³¹. Evidence from

1 other recent studies is mixed: some found no connection between religiosity and
2 disordered eating^{16,22,23}, others suggest that religiosity may protect from body
3 dissatisfaction and eating disorder symptoms^{24,28,29}, and a further two suggest the
4 opposite^{53,54}. In summary, our findings add to the evidence that overall religiosity
5 is not a central risk factor for anorexia nervosa.

6

7 When comparing our results to historical case reports, it is crucial to
8 acknowledge the importance of the relevant religious, cultural and social context.
9 The case reports of 'holy anorexia' are from a time, place, culture and society that
10 is very different from ours. Religiosity in the Middle Ages may have had
11 important differences with modern religiosity, and the women with 'holy
12 anorexia' were Catholic, not Protestant.

13 It is also important to note the anecdotal nature of evidence stemming
14 from case reports, be they modern or medieval. Because systematic population
15 studies from the Middle Ages are lacking, the prevalence of 'holy anorexia'
16 among highly religious medieval women remains unknown. It is also difficult to
17 differentiate the effects of religiosity from the effects of other factors. For example,
18 the onset of 'holy anorexia' of Saint Catherine of Siena coincided with her efforts
19 to avoid a marriage that was arranged against her will⁵. Further, it may be hard
20 to determine whether 'holy anorexia' was etiologically more about religiosity

1 that was expressed as self-starvation or self-starvation that was expressed
2 religiously.

3 If the religious, cultural and social context was important in the Middle
4 Ages, so it is today. Hence, our results need to be interpreted in their proper
5 context. Overall, Finland is ethnically highly homogenous and largely Protestant,
6 but has secularized quickly⁵⁵. Three quarters of the Finns are members of the
7 Lutheran church⁵⁶ and few Finns belong to other Christian denominations or
8 non-Christian religions. Both fasting and extremism are rare in Finland.
9 Therefore, our study mostly describes moderate Protestant Christian religiosity
10 in a modern, secular context. Extreme religiosity may also be qualitatively
11 different from the high religiosity assessed in the present paper. Further, our
12 results might not generalize to other Christian denominations or non-Christian
13 religions, or to other cultures, societies or times. Despite our negative findings,
14 religiosity may be associated with anorexia nervosa in other contexts^{57,58}.

15

16 We assessed the possible effect measure modification by the religious and
17 social context in our interaction analyses. They suggested that socioregional
18 differences in the association between religiosity and anorexia nervosa may exist.
19 Unfortunately, we were unable to replicate these findings as our measures of
20 place of residence differed between study waves.

1

2 Some factors that could have affected our findings need to be
3 acknowledged. First, retrospective diagnostic assessment can introduce
4 information bias. To reduce this risk, we analyzed a subsample limited to
5 currently symptomatic women. We found that, when compared to healthy
6 women, women currently symptomatic with anorexia nervosa were rather less
7 religious than more religious. This means that it is unlikely that a positive
8 connection between religiosity and anorexia nervosa was masked by information
9 bias.

10

11 Second, our measures of religiosity have important limitations. Direct
12 comparison between the study waves was not possible. In adolescence, and
13 among parents, we had a 12-item measure focusing on Christianity, and we also
14 analyzed the most religious decile of adolescents, but these measures did not
15 measure religiosity that does not adhere to Christian tenets. In early adulthood,
16 however, our measure was crude having only a single item and three categories.
17 It was not specific to any religion, and the distribution was severely limited with
18 few highly religious women. If religion-specific effects existed, in adolescence we
19 captured those specific to Christianity, but in early adulthood a mixture of

1 heterogeneous effects. We also had no information on the motives of personal
2 religiosity³²⁻³⁴.

3

4 Third, it is known that religiosity can change over time⁵⁹. A severe illness
5 like anorexia nervosa may have an impact on religiosity^{60,61} or on the religiosity
6 of the parents of the affected individual. We indirectly tested this in our data, but
7 found no evidence for an increased change in religiosity between study waves
8 among those affected by lifetime anorexia nervosa (Appendix H).

9

10 Fourth, missing data on religiosity may introduce bias. We used multiple
11 imputation to reduce the potential impact of missing information. We included
12 auxiliary variables to increase the plausibility of the missing at random
13 assumption. Furthermore, the results from multiple imputation and complete
14 case analysis were close to each other.

15

16 Fifth, despite nationwide sampling and high participation rates, the
17 number of women with lifetime anorexia nervosa was relatively small and
18 statistical power to detect small associations was limited, particularly for
19 subgroup analyses: the lack of statistically significant associations cannot

1 necessarily be interpreted as lack of true associations. Similarly, occasional
2 statistically significant associations may be found by chance alone.

3

4 We believe that the weaknesses of our study are offset by its important
5 strengths. We assessed religiosity and anorexia nervosa in a large, population-
6 based, nationwide cohort. The relative homogeneity of the Finnish population
7 reduces the confounding effect of minority cultures. We measured religiosity in
8 two time points and the Religious Fundamentalism content scale of the
9 Minnesota Multiphasic Personality Inventory is well-validated³⁷. In contrast to
10 earlier research, we did not rely on symptom scores only but had actual anorexia
11 nervosa diagnoses by expert clinicians.

12

13 Conclusions

14 In this population-level study among Finnish women, we studied
15 religiosity and anorexia nervosa in a highly secular context where our measures
16 of religiosity mainly reflected Christian religion. We did not find a significant
17 connection of religiosity with anorexia nervosa either at the personal or family
18 level. However, regional differences may exist, and we could not exclude the
19 possibility that religiosity might have a small positive effect on body image.
20 Despite compelling case descriptions of 'holy anorexia', religiosity does not

- 1 appear to be a central factor in the development of anorexia nervosa in present-
- 2 day Finland, a highly secularized Christian country.

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8

adolescence						
-Northern Finland	578	0.44	0.41–0.47	586	0.44	0.41–0.47
-Southern Finland	734	0.56	0.53–0.59	741	0.56	0.53–0.59
Education in early adulthood						
-non-academic	499	0.38	0.35–0.41	493	0.37	0.35–0.40
-academic	813	0.62	0.59–0.65	834	0.63	0.60–0.65
Place of residence in early adulthood	N (available for analysis)	Proportion (of total N 1227 available for analysis)		N (available for analysis)	Proportion (of total N 1247 available for analysis)	
-rural areas	286	0.23		311	0.25	
-urban areas	941	0.77		936	0.75	
Age of onset of anorexia nervosa	N	Proportion (of total N 38)		N	Proportion (of total N 53)	
≤16 years	15	0.39		24	0.45	
> 16 years	23	0.61		29	0.55	

1

2 Legend: Maternal religiosity, paternal religiosity and religiosity in adolescence

3 measured on the Religious fundamentalism content scale of the Minnesota

4 Multiphasic Personality Inventory when the women were 16 year adolescents.

5 Religiosity in early adulthood measured when the women were 22–27 years old.

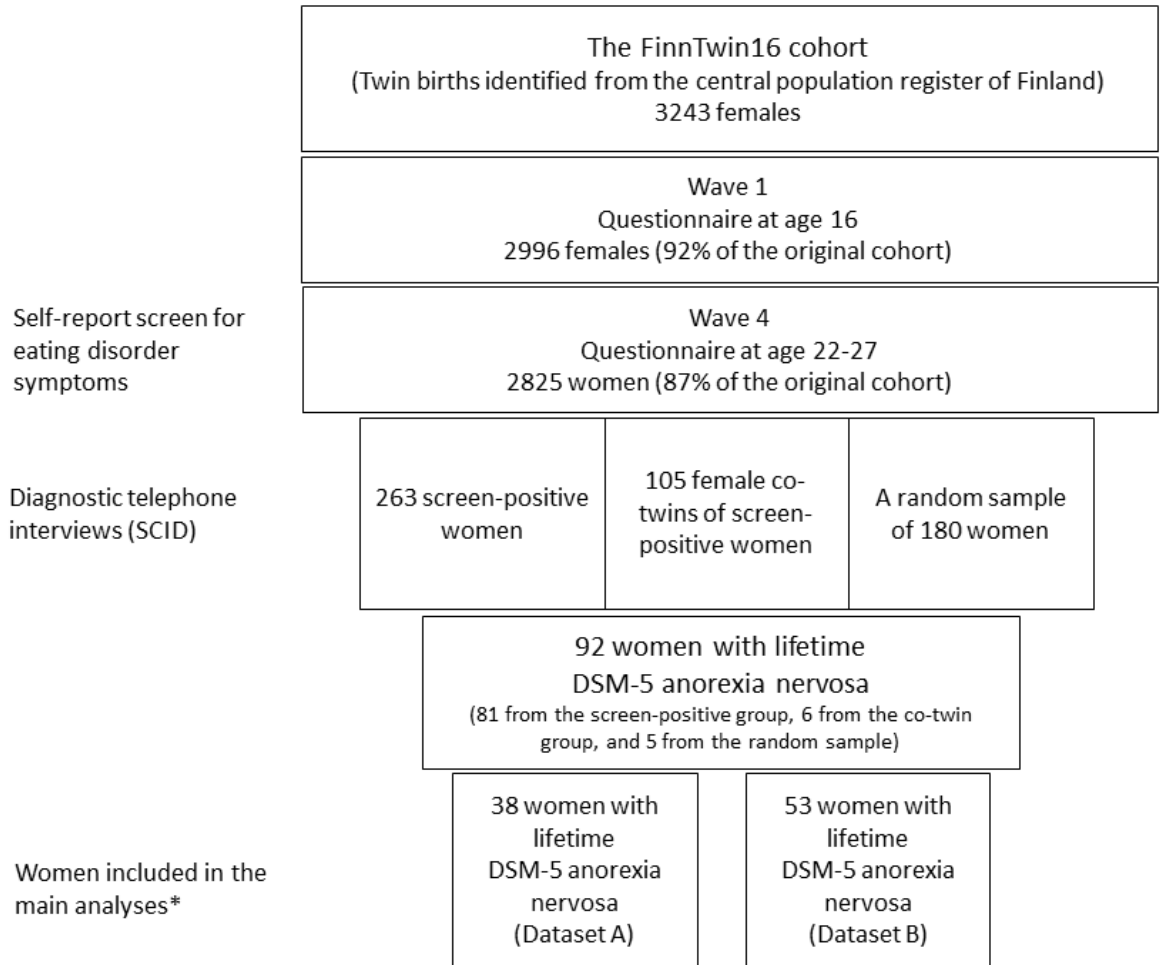
6 95% CI, 95% confidence interval; SD, standard deviation. *Numbers may not add

7 up to total N because of rounding.

8

1 Figure 1. Flowchart of the study cohort

2

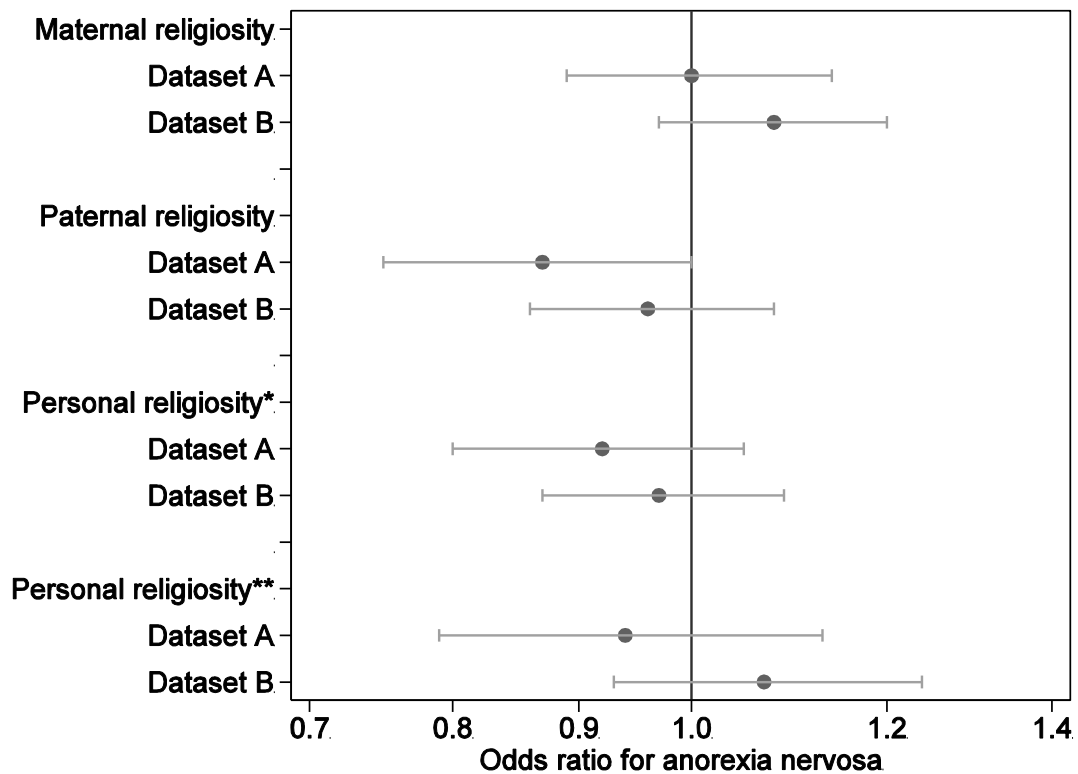


*One woman with anorexia nervosa was living on the Åsland Islands and was excluded.

3

4

1 Figure 2. Odds ratios for lifetime DSM-5 anorexia nervosa by unit increase in
 2 religiosity. Religiosity measured on the Religious fundamentalism content scale
 3 of the Minnesota Multiphasic Personality Inventory when the women were 16
 4 year adolescents.



5

6

7 Legend: *Personal religiosity in adolescence; **Personal religiosity in adolescence

8 with anorexia nervosa onset after the measurement of religiosity; the bars mark

9 the 95% confidence intervals. Odds ratios are on a logarithmic scale. The analyses

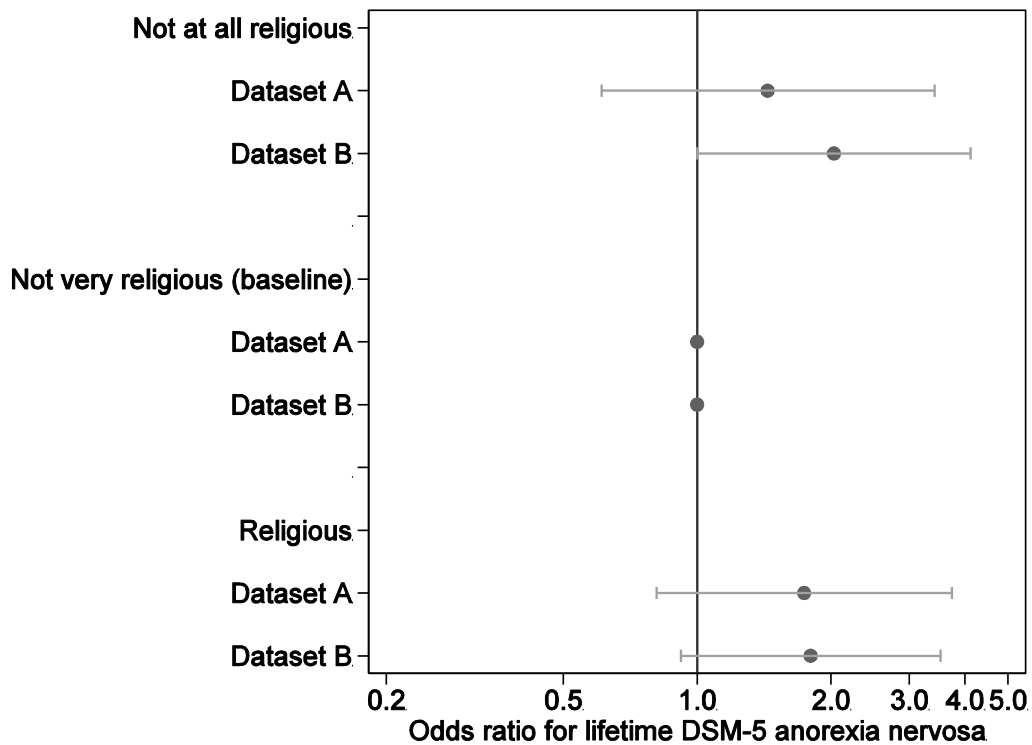
10 are based on 1312 women (38 had anorexia nervosa) in Dataset A and 1327

11 women (53 had anorexia nervosa) in dataset B. The analyses of anorexia nervosa

12 onset after the measurement of religiosity are based on 1297 women (23 had

- 1 anorexia nervosa) in dataset A and 1303 women (29 had anorexia nervosa) in
- 2 dataset B.

- 1 Figure 3. Odds ratios for lifetime DSM-5 anorexia nervosa by religiosity in early
 2 adulthood (when the women were 22–27 years old). The ‘not very religious’
 3 category is the reference (odds ratio = 1).



- 4
 5 Legend: The bars mark the 95% confidence intervals. Odds ratios are on a
 6 logarithmic scale. The analyses are based on 1312 women (38 had anorexia
 7 nervosa) in Dataset A and 1327 women (53 had anorexia nervosa) in dataset B.
 8 The estimated proportions of women having anorexia nervosa in datasets A and
 9 B were as follows: among not at all religious 3.2% and 5.5%, among not very
 10 religious 2.2% and 2.8% and among religious 3.8% and 4.9%.

11

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2

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5

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12

1 Supplemental Materials: For Online Publication Only

2 Appendix A

3

4 The 12-item Religious fundamentalism content scale of the Minnesota

5 Multiphasic Personality Inventory (MMPI).

6

7 1. Everything is turning out just like the prophets of the Bible said it would

8 2. I go to church almost every week

9 3. I believe in the second coming of Christ

10 4. I believe in a life hereafter

11 5. I am very religious (more than most people)

12 6. I believe there is a Devil and Hell in the afterlife

13 7. I believe there is a God

14 8. I feel sure that there is only one true religion

15 9. Christ performed miracles such as changing water into wine

16 10. I pray several times a week

17 11. I read the Bible several times a week

18 12. I have no patience with people who believe there is only one true religion

19

1 Legend: For items 1–11, endorsing 'True' is scored 1 and endorsing 'False' is
2 scored 0. Item 12 is reversed ('True' is scored 0 and 'False' is scored 1). The score
3 for the 12-item Religious fundamentalism content scale is the sum of scores for
4 items 1–12.

5

6 Wording from: Winter T, Kaprio J, Viken RJ, Karvonen S, Rose RJ. Individual
7 differences in adolescent religiosity in Finland: familial effects are modified by
8 sex and region of residence. *Twin Res.* 1999;2(2):108-114.

1 Appendix B

2 Detailed description of the datasets, multiple imputation and auxiliary religiosity
3 measures.

4

5 Datasets

6

7 Because our data consists of twin pairs, the observations concerning twin
8 individuals are not independent of each other. Therefore, we divided each twin
9 pair to two separate datasets. Individuals with even id numbers were assigned to
10 dataset A and individuals with odd id numbers were assigned to dataset B. The
11 internal id numbers were assigned prior to data collection. This resulted in two
12 datasets that consist of independent observations. However, the datasets are not
13 independent of each other, and fathers and mothers of complete twin pairs
14 belong to both datasets.

15

16 We excluded from both datasets women with missing information on
17 lifetime DSM-5 anorexia nervosa status, because they were the women who
18 could be considered neither healthy nor affected by anorexia nervosa. We also
19 excluded the few women living on the Åland Islands³⁸. After these exclusions,
20 dataset A consisted of 1312 women of whom 38 had a diagnosis of lifetime DSM-

1 5 anorexia nervosa, and dataset B consisted of 1327 women of whom 53 with
2 lifetime DSM-5 anorexia nervosa. The analyses of DSM-5 anorexia nervosa with
3 age of onset after 16 years were based on 1297 women and 23 anorexia nervosa
4 cases in dataset A and 1303 women and 29 anorexia nervosa cases in dataset B.

5

6 Before multiple imputation, we had a high percentage (94–95%) of
7 complete information from the single question on personal religiosity in early
8 adulthood. The percentage of complete information was lower from religiosity in
9 adolescence and from religiosity of parents (59–70%). Complete information for
10 all the variables used in the multiple imputation was available from 22–28% of
11 women in our datasets.

12

13 Multiple imputation

14

15 We used Substantive-model compatible fully conditional specification
16 (SMC-FCS) multiple imputation to impute missing covariates for main
17 analyses^{49,50}. In the SMC-FCS, we modeled discrete (e.g. religiosity in wave 1) and
18 categorical variables with ordered logistic regression and binary variables with
19 logistic regression. To account for possible non-linear effects, we also examined

1 substantive models with quadratic effects of the religiosity variables from wave 1,
2 and found that their fit was not significantly better from linear models.

3

4 In multiple imputation, we used information on all relevant variables:

5 personal, maternal and paternal religiosity at wave 1, personal religiosity at

6 wave 4, place of residence at wave 1, education at wave 4 and lifetime anorexia

7 nervosa status (with or without information on age of onset). We also included

8 interactions between religiosity variables in wave 1 and place of residence in

9 wave 1. To improve the quality of multiple imputation, we used two auxiliary

10 multiple-choice items from wave 4: church going frequency and the importance

11 of the religiosity of partner and peers. Church going frequency (“Not counting

12 weddings, funerals and baptism how often do you go to church or other

13 religious events?”) had five response alternatives: 1) once a week, 2) once a

14 month, 3) once a year, 4) less often and 5) not at all. We merged categories 1) and

15 2) because of few responses in them. The importance of the religiosity of the

16 partner and peers (“How important to you is the religious faith of your girl-

17 /boyfriend or the faith of your close friends?”) similarly had five response

18 alternatives: 1) very important, 2) important, 3) not very important, 4) not at all

19 important and 5) cannot say. We considered category 5) missing information.

20

1 We performed multiple imputation separately for each dataset to impute
2 the missing values. To ensure compatibility with the substantive model, we
3 based analyses on the two different outcomes (lifetime anorexia nervosa and
4 anorexia nervosa with age of onset >16 years) on separate multiple imputation
5 models with separate substantive models. To achieve low Monte Carlo errors, we
6 used 200 imputations per multiple imputation model. Further, to ensure proper
7 convergence of the chained equations, we used 100 burn in iterations for each
8 imputation. The adequacy of the multiple imputation was checked by comparing
9 the distributions of the observed and imputed values, by graphically checking
10 the convergence of the burn in iterations and by checking the Monte Carlo errors
11 as recommended by White et al⁵².

12

13 Additional analyses concerning currently symptomatic women, place of
14 residence in early adulthood and EDI-2 subscales⁴¹ in early adulthood were
15 based on complete cases after stepwise deletion in datasets A and B because of
16 sparse data or limited number of substantive models supported by the SMC-FCS
17 multiple imputation statistical package. However, there were only few missing
18 information in these analyses. Complete information was available from 97–99%
19 of women for place of residence and EDI-2 subscales and from 94–95% of women

1 for religiosity in early adulthood. Information on current symptoms was
2 complete for those with lifetime DSM-5 anorexia nervosa.

3

4 Aggregate measure of religiosity in early adulthood

5

6 In early adulthood, we used information from all relevant variables to
7 construct an aggregate measure of religiosity. These were scored as follows:
8 religiosity “religious” (3), “not very religious” (2), and “not at all religious”(1);
9 church going frequency “once a week or once a month” (4), “once a year” (3),
10 “less often” (2) and “not at all” (1); the importance of the religiosity of the partner
11 and peers “very important (4)”, “important” (3), “not very important” (2) and
12 “not at all important” (1). We summed up the scores from all these three
13 variables to yield an aggregate measure of religiosity that ranged from 3 to 11.
14 The Cronbach’s alphas were 0.77–0.78 among the complete cases in datasets A
15 and B.

16

17 Tertiles of religiosity and change in religiosity

18 To assess change in personal religiosity between study waves, we used
19 tertile splits of religiosity both in adolescence and in early adulthood.

20

1 In adolescence, we simply split the Religious fundamentalism content
2 scale of the Minnesota Multiphasic Personality Inventory^{37,38} (Appendix 1) into
3 tertiles. In early adulthood, we split the aggregate measure of religiosity into
4 tertiles.

5

6 Women who were in the same tertile of religiosity in both study waves
7 were defined to be a reference group. Others were divided to those with
8 increasing and decreasing religiosity. Then, we used multinomial logistic
9 regression to calculate relative-risk ratios for increasing and decreasing
10 religiosity between the study waves by lifetime DSM-5 anorexia nervosa status.

11

12

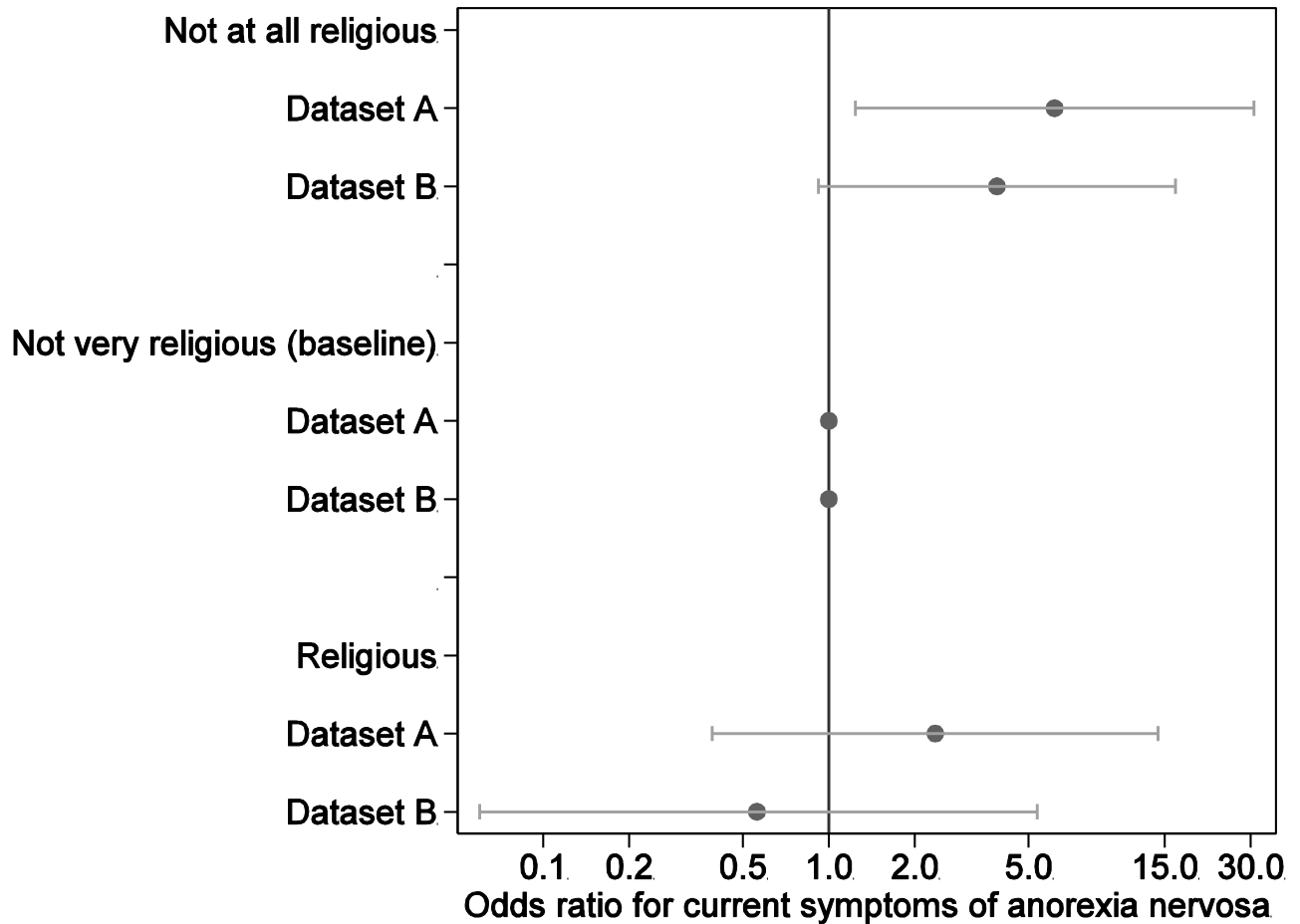
References for Appendix B

13 Please see the corresponding reference numbers in the main text.

14

1 Appendix C. Odds ratios for current symptoms of anorexia nervosa* in early
 2 adulthood by religiosity in early adulthood.

3



4
 5 Legend: *Currently symptomatic women compared to healthy women. Early
 6 adulthood when the women were 22–27 years old. The bars mark the 95%
 7 confidence intervals. Odds ratios are on a logarithmic scale. The numbers were
 8 as follows (in Datasets A and B, respectively): 281 and 260 not at all religious (6
 9 and 5 of whom had current symptoms), 568 and 596 not very religious (2 and 3 of

1 whom had current symptoms) and 362 and 357 religious (3 and 1 of whom had

2 current symptoms).

3

- 1 Appendix D. Odds ratios for current symptoms of anorexia nervosa* in early
- 2 adulthood by unit increase in religiosity in adolescence.

Dataset A					
	N total	N anorexia nervosa	OR	95% CI	p-value
Religiosity in adolescence	895	8	0.69	0.48–0.98	0.04
Dataset B					
	N total	N anorexia nervosa	OR	95% CI	p-value
Religiosity in adolescence	905	8	0.80	0.59–1.09	0.16

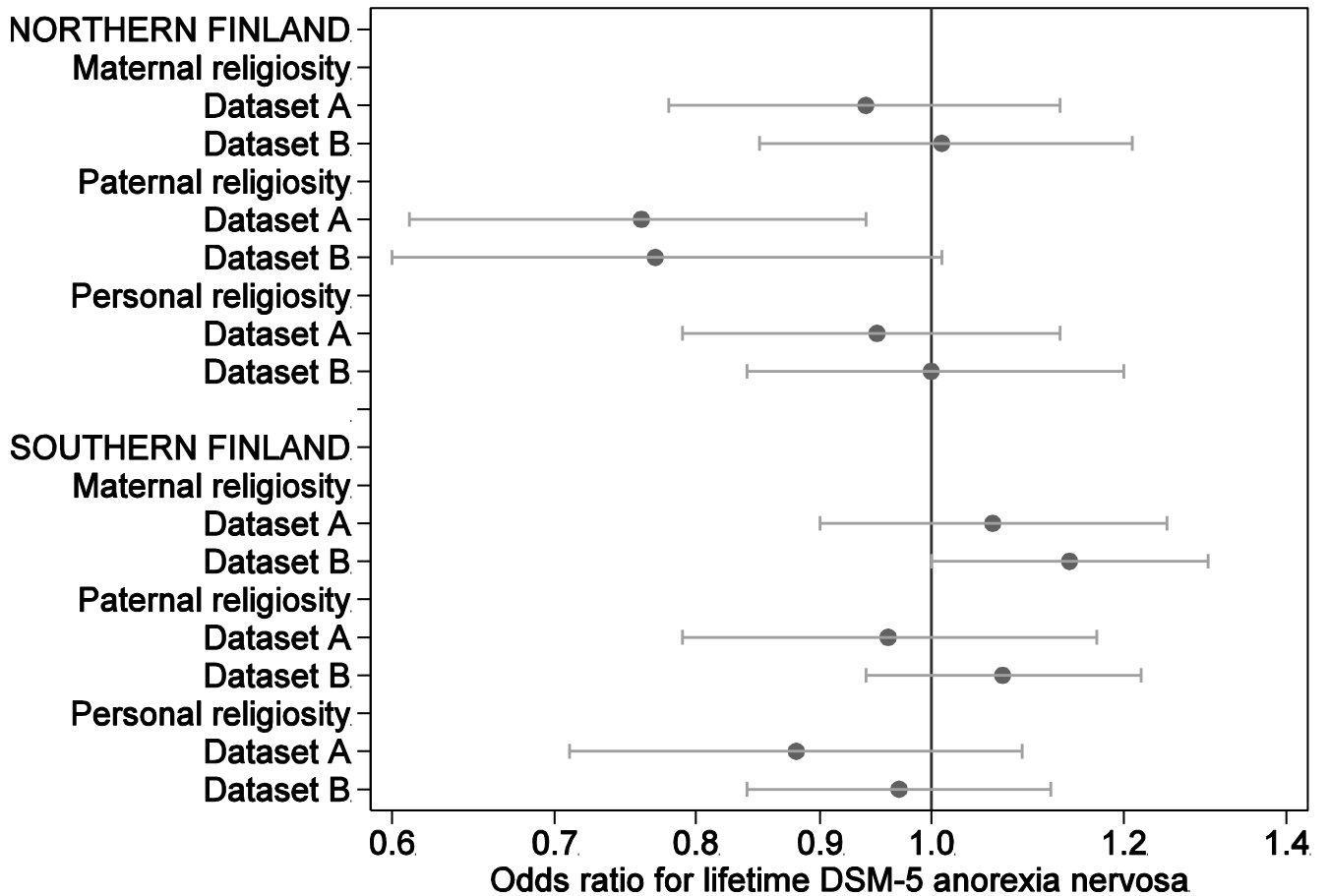
3

- 4 Legend: *Currently symptomatic women compared to healthy women. Early
- 5 adulthood when the women were 22–27 years old. Adolescence when the
- 6 women were 16 years old. OR, odds ratio; 95% CI, 95% confidence interval.

7

8

1 Appendix E. Odds ratios for lifetime DSM-5 anorexia nervosa in Northern and
 2 Southern Finland by unit increase in religiosity. Religiosity measured on the
 3 Religious fundamentalism content scale of the Minnesota Multiphasic
 4 Personality Inventory when the women were 16 year adolescents.
 5

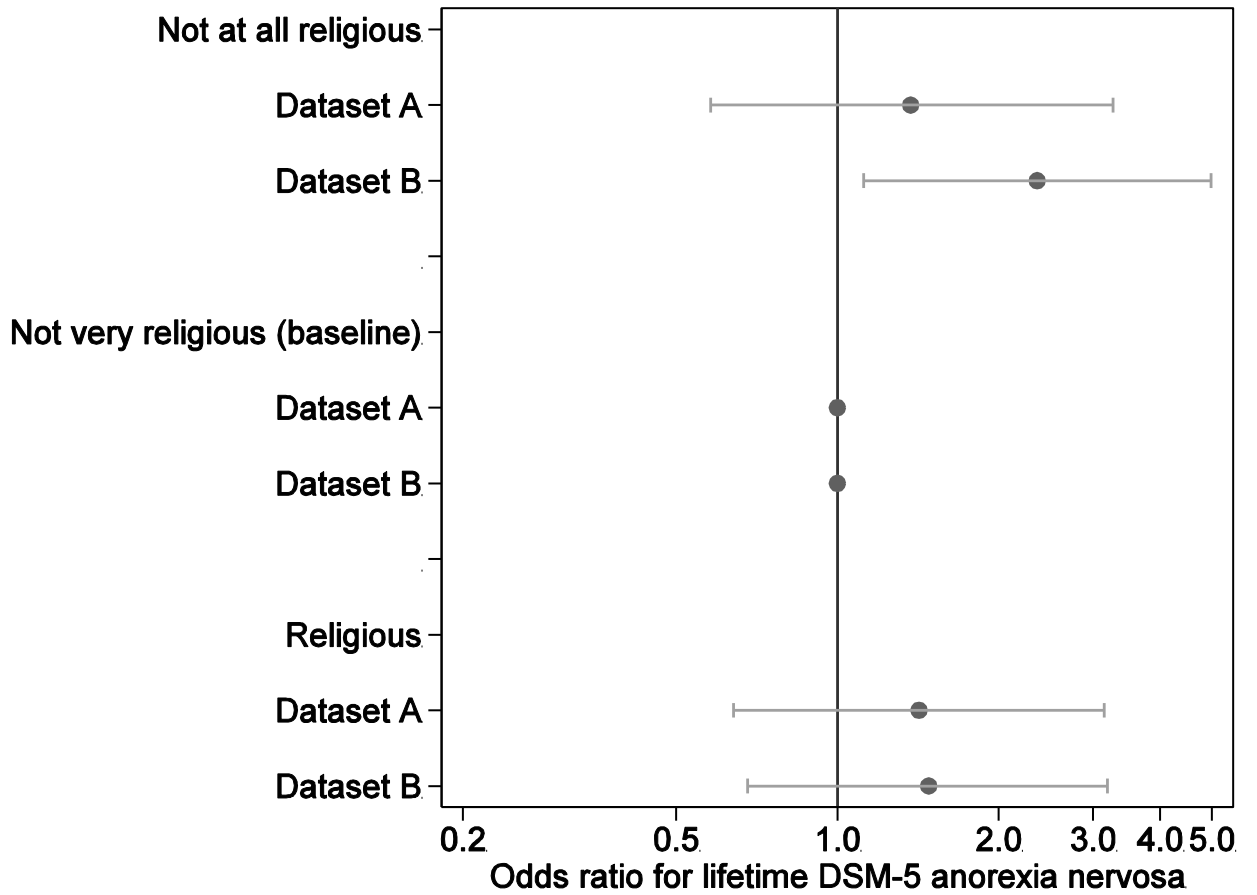


6 Legend: The bars mark the 95% confidence intervals. Odds ratios are on a
 7 logarithmic scale. The analyses are based on 1312 women (38 had anorexia
 8 nervosa) in Dataset A and 1327 women (53 had anorexia nervosa) in dataset B.
 9

- 1 The estimated proportions living in Northern and Southern Finland were 44%
- 2 and 56% in both datasets.

1 Appendix F. Odds ratios for lifetime DSM-5 anorexia nervosa by religiosity (not
 2 very religious being the reference group) in early adulthood (when the women
 3 were 22–27 years old). Analysis restricted to urban areas.

4



5

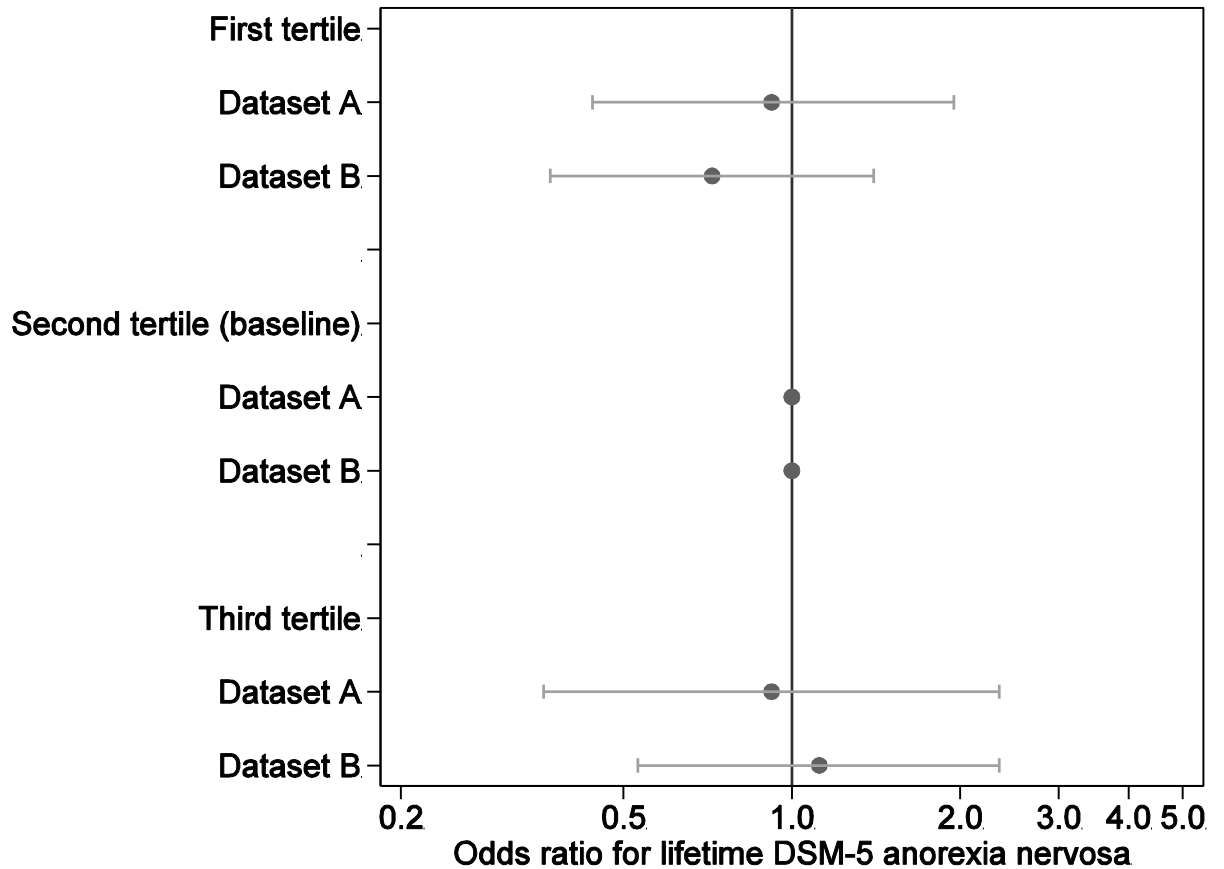
6

7 Legend: The bars mark the 95% confidence intervals. Odds ratios are on a
 8 logarithmic scale. The number were as follows (in Datasets A and B,
 9 respectively): 221 and 210 not at all religious (9 and 15 of whom had anorexia

- 1 nervosa), 434 and 443 not very religious (13 and 14 of whom had anorexia
- 2 nervosa) and 286 and 283 religious (12 and 13 of whom had anorexia nervosa).

1 Appendix G. Odds ratios for lifetime DSM-5 anorexia nervosa by tertiles of
 2 religiosity in early adulthood (when the women were 22–27 years old).

3



4

5

6

7 Legend: The bars mark the 95% confidence intervals. Odds ratios are on a

8 logarithmic scale. The analyses are based on 1312 women (38 had anorexia

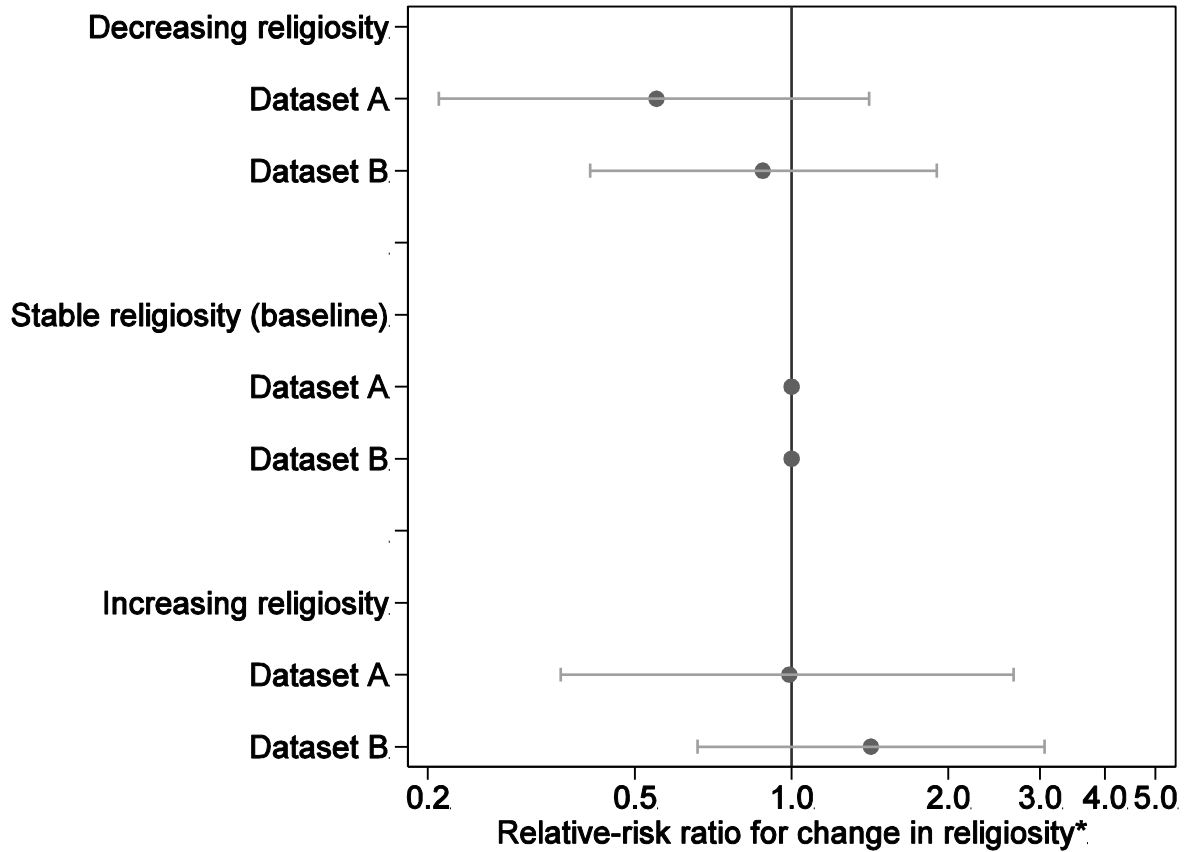
9 nervosa) in Dataset A and 1327 women (53 had anorexia nervosa) in dataset B.

10 The estimated proportions of women having anorexia nervosa in datasets A and

11 B were as follows: among the first tertile (least religious) 2.8% and 3.3%, among

- 1 the second tertile (baseline) 3.1% and 4.5%, and among the third tertile (most
- 2 religious) 2.8% and 5.0%.
- 3

1 Appendix H. Relative-risk ratios for decreasing and increasing religiosity
 2 between study waves for those with lifetime DSM-5 anorexia nervosa (when
 3 compared to healthy women)
 4



5
 6
 7 Legend: *Relative-risk ratios are for those with lifetime DSM-5 anorexia nervosa
 8 when compared to healthy women. The bars mark the 95% confidence intervals.
 9 Relative-risk ratios are on a logarithmic scale. The analyses are based on 1312
 10 women (38 had anorexia nervosa) in Dataset A and 1327 women (53 had
 11 anorexia nervosa) in dataset B. The estimated proportions of women having

- 1 anorexia nervosa in datasets A and B were as follows: among those with
- 2 decreasing religiosity 1.9% and 3.4%, among those with stable religiosity 3.3%
- 3 and 3.8%, and among those with increasing religiosity 3.3% and 5.4%.
- 4