Hypothesis 8: That Perceived Risk of exposure to Chornobyl radiation explains and predicts self-reported illnesses as measured by the Nottingham Health Profile

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Contents

1 Acknowledgements

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2 Introduction

There is no established health threat scale. We formulate one by computing the factor score of the Chornobyl related health threat to oneself (radhlw1 radhlw2 -radhlw3), one's family (radfmw1 radfmw2 radfmw3), and one's community (kzchorn). The latter variable is a measure of the extent to which people believe that the cancer cases in the Zhitomyr and Kyiv (Kiev) Oblast are due to Chornobyl. A scale score was generated for each wave. Depending upon the wave under consideration, we call this variable (crhtw1 crhtw2 crhtw3). The alpha reliabilities for these summary scales were 0.769, 0.822, and 0.835) respectively.

The Nottingham health profile consists of several domain subscales. Most prominent among them is the pain domain. The profile also includes such domains as physical ability, social isolation, sleep, and energy level subscales and their reliabilities are discussed earlier in the report.

Each analysis is performed by gender. The wave designations of the variables are suffixes after a w, indicating whether the variable pertained to wave one (1986 after Chornobyl), wave two, the following decade (Jan 1, 1987 through December 31, 1996), and wave three (January 1, 1997 through the time of the interview).

3 Hypothesis Eight

Hypothesis eight postulates that perceived risk of exposure as measured by the above summary score (crhtw1 through crhtw3) predicts self-reported illnesses as measured by the Nottingham Health Scale. In order to test this hypothesis, we need to define our terms. To refine our sense of relationship between the our summary score and these variables, it is necessary to have a sense of what the range of these variables is and how the observations are distributed. We therefore begin with an examination of the summary statistics for the Nottingham health subscale scores relating to psychological domain specific health problems, with higher scores indicating more health problems.

3.1 Summary statistical characteristics of key variables

Table 1a Male Endogenous variables Nottingham heath subscale scores

stats	whppain	whppa	whpsoc~o	whpsleep	whpel
N	339	339	339	339	339
mean	10.20968	9.512625	6.330561	17.34791	23.1882
p50	0	0	0	0	0
sd	16.46631	14.56254	14.86534	24.84498	30.03647
se(mean)	.894327	.7909285	.8073742	1.349394	1.631357
skewness	1.74253	1.771128	2.818294	1.516516	.9421123
kurtosis	5.454974	6.244686	11.9889	4.480959	2.666238
min	0	0	0	0	0
max	82.75	87.27999	100	101	100
range	82.75	87.27999	100	101	100

Table 1b Female Endogenous variables Nottingham heath subscale scores

stats	whppain	whppa	whpsoc~o	whpsleep	whpel
N	363	363	363	363	363
mean	18.01157	18.46551	10.28085	26.24466	31.83691
p50	9.99	11.2	0	12.57	24
sd	22.32649	21.43057	18.76083	30.90295	34.44306
se(mean)	1.171837	1.124813	.9846881	1.621984	1.807792
skewness	1.147824	1.277785	2.168495	1.084023	.6682731
kurtosis	3.304064	4.778915	7.870519	3.007434	2.169185
min	0	0	0	0	0
max	82.75	99.96999	100	101	100
range	82.75	99.96999	100	101	100

For each subscale, we provide the number of observations, the mean, median, standard deviation, standard error of the mean, skewness, kurtosis, minimum, maximum and range in Table one.

In Table two, we provide the same statisitics for the summary perceived Chornobyl health threat score.

Table 2a Male perceived Chornobyl-related health threat in waves one, two, and three

stats	crhtw1	crhtw2	crhtw3
N	339	339	339
mean	-.1421184	-.1840074	-.1842635
p50	-.3135327	-.3123638	-.3142916
sd	.9297899	.9217839	.9209234
se(mean)	.0504993	.0500644	.0500177
skewness	.2685256	.1426297	.1072786
kurtosis	1.723372	1.784132	1.750789
min	-1.501544	-1.819979	-1.788638
max	1.247565	1.195251	1.160055
range	2.74911	3.01523	2.948694

Table 2b female perceived Chornobyl-related health threat in waves one, two, and three

stats	crhtw1	crhtw2	crhtw3
N	362	363	363
mean	.1330888	.1718416	.1720808
p50	-.0271604	.0978736	.2342184
sd	.9446965	.8710879	.8910531
se(mean)	.0496521	.0457203	.0467682
skewness	-.1395848	-.3168993	-.3923478
kurtosis	1.558054	1.959277	1.914075
min	-1.501544	-1.819979	-1.788638
max	1.247565	1.195251	1.160055
range	2.74911	3.01523	2.948694

Although the male mean of perceived threat might seem to decline over time, the female mean rises. What matters more, however, is the relationship that these sets of scores have with one another. We will begin to examine that relationship in the next section.

4 Methodology

4.1 Sampling and response validation

We used random digit phone number selection to generate phone numbers. To each of the area codes provided by the telephone company in the Ukraine, we generated a series random numbers which were then attached to the area codes. Approximately 14% of these numbers generated turned out to be actual phone numbers. Nonetheless, the procedure allowed for a probability sampling, which could after preliminary analyses were completed, be done with sampling weights to estimate population totals of our analysis.

Because the sampling was performed with random selection of phone numbers we had the choice of building models for totals or design-driven models at first and then population totals at the end of the project. We opted for this approach to facilitate parsimonious variable selection.

The data were collected and input by our Kiev team led by Drs. Victor Chtengulov and Gleb Prieb in Kiev. An independent auditing group would contact the respondent after the interview was completed and only after determining that the responses were completely voluntary with no effort to bias the results, was permission given to upload the data into a file, which was put in SPSS format by Vovici Corp. We took those files and immediately converted them to Stata and AutoMetrics files. Some files were converted to SAS and WinBUGs for supplementary Bayesian analysis.

4.2 Periodization of the analysis

To minimize recall bias, we could not use equidistant five year periods over 30 years, except only for salient psychological phenomena. For pronounced effects, we asked the year the condition began and the year it ended. We asked for salient changes of intensity during that spell. But for most things, we had to keep the periodization to a minimum. Therefore we split that into three waves– the year of the event, the decade after, and the time from 1997 to the time of the interview. However, for dose reconstruction, we cut off that estimation at the year of 2009, when we began the interviews after the pilot study was completed.

4.3 Gender specific analysis

Because these data are psycho-social medical data, models are run separately for males and females throughout the analysis. The different results for males and females may be compared in a separate analysis.

4.4 Covariate selection

To be sure that the proper covariates were entered as controls and to minimize the specification error that would stem from omitted variable bias, the general to specific search was employed.

Hypothesis eight focuses on the relationship between perceived threat and health problems as measured by the Nottingham part I subscales. Because pictures contain a lot of information which the analyst can grasp at once, we begin our analysis with graphs of the impact on health, first for men and then for women, over time. These graphs are combinations of lowess plots superimposed on scatterplots. With respect to each of the Nottingham health subscales, there is an increasing impact over time as can be seen in Figures one through ten.

We include socio-demographic variables as covariates–such as age, education, marital status, occupation, and income sufficiency. We also include the geodesic distance of the residence from the accident site in 1986. We include average cumulative reconstructed dose of ^{137}CS as a maker variable for deposition of radioactive material. We include self-reports of the numbers of illnesses recounted by the respondent as well as the number of medically diagnosed diseases experienced by the individual from available records made available.

4.5 Health information privacy protection

After the data cleaning and checking phase was completed regarding such data, the names and addresses of the respondents were removed from the analyst's data files by a program written by Jonathan Yaffee in Java to find all the data files on the computer and by Robert A. Yaffee to purge those data files of the names and addresses of respondents to secure the privacy, confidentiality, and anonymity of the respondents from abuse or misuse of such data.

4.6 Age-cohort-period decomposition

We always include age as a covariate. Yang and Land (2008) describe age effects as those associated with

> ...physiological changes, accumulation of social experience, and/or role or status changes. Period effects represent variation over time periods (waves) that effect all age groups simultaneously– often from shifts in social, cultural or physical environments. [1, 298].

Cohort effects stem from the date of birth of the respondent and events that affect all groups of respondents similarly owing to a common formative experience they endure. As Yang and Land note, the linear dependency from period equalling age plus cohort makes identification of these effects problematic.

In this dataset, we designate the period or wave effect as a w1, w2, or w3 suffix at the end of the variable name. Age is defined separately. However, because

$$Period = Age + Cohort \tag{1}$$

the linear dependency continues to plague identification of these traits. We could treat this model as a hierarchical model with period as an upper consisting of period and age effects.

One approach is to sort the birthdates by age and separate them at five year intervals and give a cohort designation to each. We do that and construct a bcohort variable that can be used with our wave designation and age to help us try to distinguish one effect from the other. We will find birth cohort emerges as a factor when considering the physical ability of women in this analysis.

Minimization of specification error is undertaken with AutoMetrics variable selection, using the general to specific model building approach in accordance with linear regression model reduction theory[3, 166-189,226-287].

The wave for each variable is indicated so we can distinguish the value of a variable in one wave from its value in another. But these waves are not temporally equal. The first wave extends from the date of Chornobyl to the end of the same year. The next wave covers the following decade. The third wave extends from January 1st 1997 until the time of the interview. But the interviews were conducted over a three year period. To assure uniformity in the dose reconstruction, however, that was ended on January 1, 2009, which was the time the interviews began.

4.7 Robust variance estimators

To protect against heteroskedasticity, we employed in a cross-sectional framework robust variance estimators. When the model was rerun in Stata, we used a robust cluster control of serial correlation between the variables by permitting clustering by the respondent id.

5 Findings

5.1 Health trends with respect to perceived risk of exposure

From these graphs, we observe an increase in health problems associated with and increase in perceived Chornobyl health threat over time. By controlling for potentially confounding factors, such as age, we will endeavor to distinguish the effects due to age from those due to perceived health threat, and those peculiar to the period or wave itself.

We try to control for age, birth cohort, and period effects by including age as a covariate, constructing a birth cohort variable for age groups five years apart, and using period specific variables, specific to our values for the wave.

After performing a search for potential covariates with AutoMetrics, and in addition to the usual covariates of age, socio-demographic status, the number of medically diagnosed illnesses on the part of the respondent, self-perceived Chornobyl health threat to oneself and one's family, belief in the amount of pollution due to Chornobyl and the basis for the cancer rate in their area of

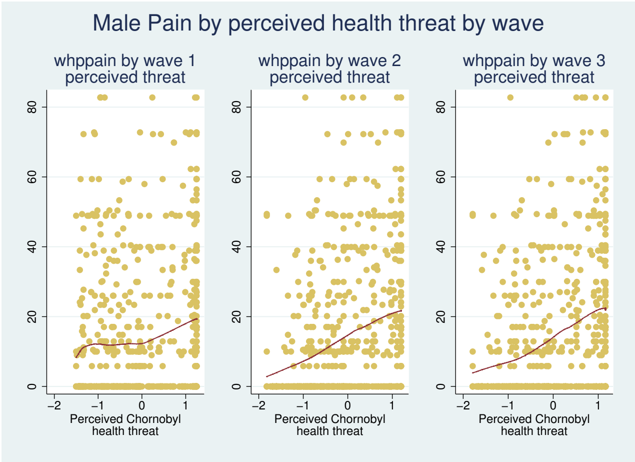

Figure 1: **Male Nottingham pain subscale by perceived Chornobyl related health threat by wave**

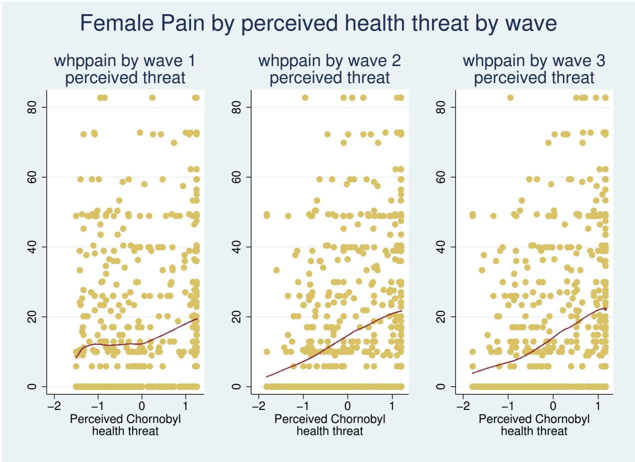

Figure 2: **Female pain by perceived Chornobyl related health threat by wave**

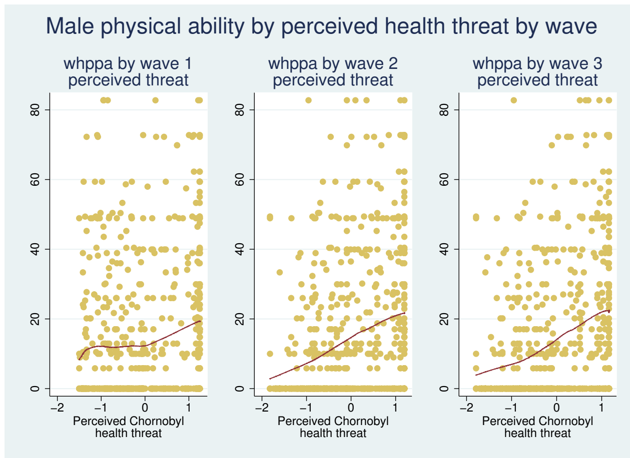

Figure 3: **Male physical ability by perceieved Chornobyl related health threat by wave**

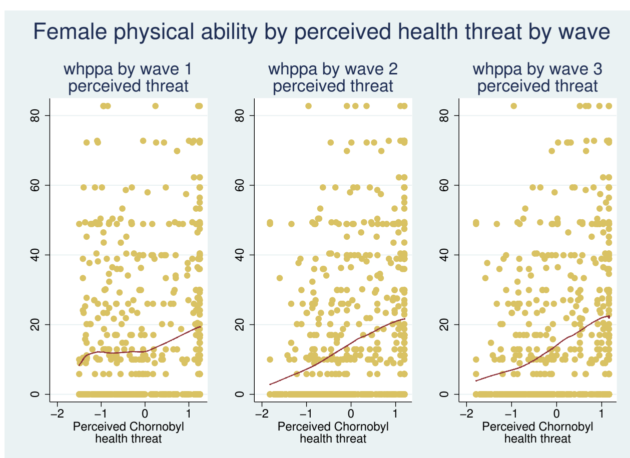

Figure 4: **Female physical ability by perceived Chornobyl related health threat by wave**

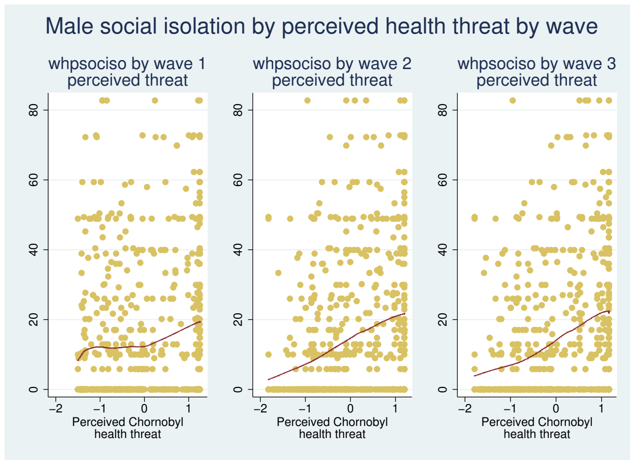

Figure 5: **Nottingham social isolation male scores by perceived Chornobyl related health threat over three waves**

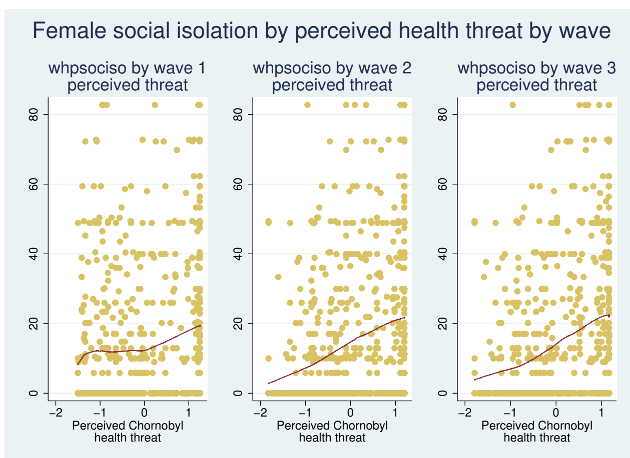

Figure 6: **Nottingham social isolation female scores by over three waves**

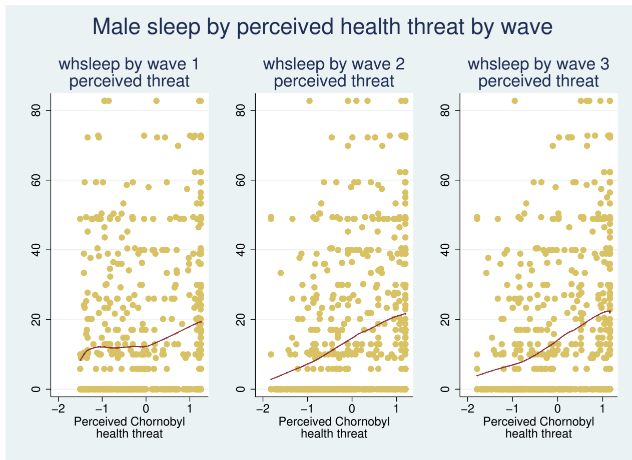

Figure 7: **Nottingham sleep male scores by perceived Chornobyl related health threat over three waves**

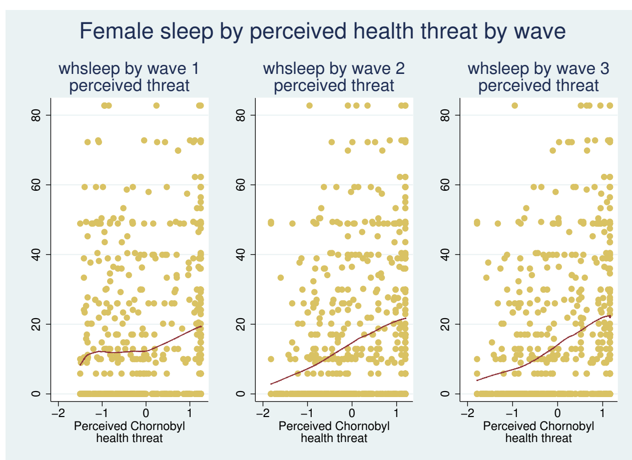

Figure 8: **Nottingham sleep female scores by perceived Chornobyl related health threat over three waves**

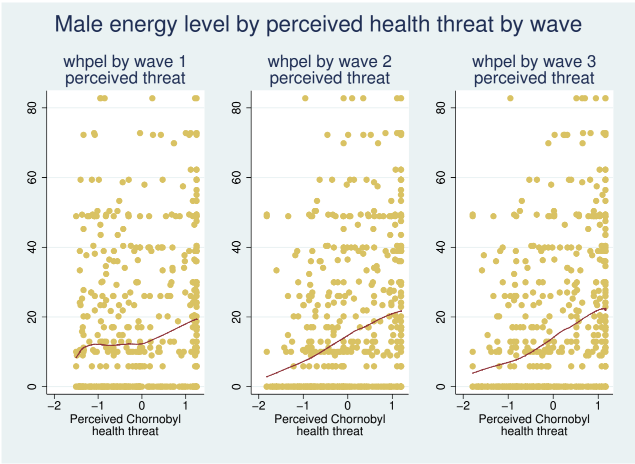

Figure 9: **Nottingham energy level female scores by perceived Chornobyl related health threat over three waves**

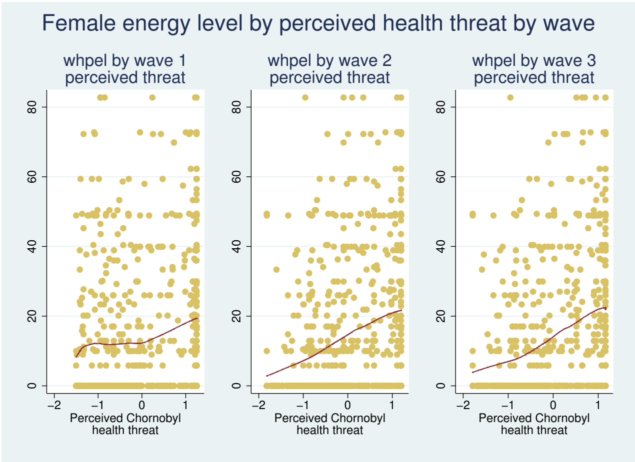

Figure 10: **Nottingham energy level female scores by perceived Chornobyl related health threat over three waves**

residence, as well as the self-reported depression and anxieties on the previous waves of the study to control for potentially confounding influences, we want to ascertain whether the zero-order relationship apparent in the graphs is maintained, or whether it is merely an effect of the confounding covariates.

Those covariates which enhance the pain, sleep, physical disability, social isolation, and energy level problems are stressors, and those covariates which reduce these adverse effects serve as buffers. In the midst of the competing stressors and buffers, it is important for us to understand whether these effects sustain a significant relationship with the summary Chornobyl related health threat score, or whether they do not. In the first three tables, we summarize the main effects findings of the hypothesized relationships between the summary scores and the health effects, after inclusion of potential confounding main effects.

6 Discussion

The first three tables present the significance or non-significance of direct effects comprising the hypothesized relationship at each wave been the summary Chornobyl related health threat and the Nottingham part one subscale indicating aspect of his health. The second set of three tables indicates whether there are significant moderating effect impacting the direct effect, and the third set of three tables indicates which variables provided significant circumventions of the direct path through a zero-order test for an indirect effect. The third set of three tables will have to be followed up with a more elaborate path model to determine whether they are robust enough to withstanding the conflicting pressures of other confounders.

6.1 Direct effects with confounding stressors and buffers

In Tables 1 through 3, we list the direct effects found to be statistically significant when included buffers and stressors identified as statistically significant by AutoMetrics and also confirmed by our Stata models. If the relationship between the summary perceived risk and pain subscale was not found to be statistically significant, we inserted an "ns" in the table below to indicate the results of the test. In later tables, where we were not testing a specific hypothesis, we just use a "-" to indicate that there there was no noteworthy result.

Table 1: Wave 1: Summary main effects of perceived risk and impact on health

Nottinham Subscale score	**Male Models**	**Female Models**
Pain subscale	ns	ns
Physical ability	ns	ns
Social isolation	ns	ns
Sleep	ns	ns
Energy level	ns	ns

Table 2: Wave 2: Summary perceived risk and impact on health

Nottinham Subscale score	Male Models	Female Models
Pain subscale	ns	ns
Physical ability	ns	ns
Social isolation	ns	ns
Sleep	ns	ns
Energy level	ns	ns

Table 3: Wave 3: Summary perceived risk and impact on health: Trimmed main effects model

Nottinham Subscale score	Male Models	Female Models
Pain subscale	(crhtw1 b=4.611 p=0.045)	ns
Physical ability	ns	ns
Social isolation	ns	(crhtw3 b=7.01 p= 0.034)
Sleep	ns	ns
Energy level	ns	ns

The remarkable finding is that almost none of the direct effects appear to withstand the pressures of potential confounders. The excepts are the relationship between the summary score of Chornobyl related health threat in wave three to pain for males and in wave three for female social isolation The coefficients will vary slightly if we use the trimmed rather than the full model or the moderator model rather than the main effects model. We provide the coefficients for the trimmed main effects model in the above table. When a wave 1 coefficient becomes significant in a wave three model, this may represent a retrospective interpretation if the coefficient is not significant in the wave one model as well.

When those variables are added to the model, the signifcance of the direct effects pales and becomes indistinguishable from the noise in all other cases. A full exploration of the indirect and moderating effects will provide us with an inkling as to myriads of alternative paths to the emergence of the symptomatology. In the meantime, we examine first-order indicators of moderating and intervening effects.

The models that account for these results are displayed below:

Trimmed Male Pain main effects model

```
Linear regression                                      Number of obs =     339
                                                       F( 16,   338) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.6307
                                                       Root MSE      =  10.268

                                   (Std. Err. adjusted for 339 clusters in id)
```

whppain	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
age	.0636237	.0613121	1.04	0.300	-.0569776	.184225
inc4w1	-4.748577	2.091951	-2.27	0.024	-8.86346	-.6336943
occ5w3	-5.01775	2.389459	-2.10	0.036	-9.717834	-.3176657
suchrw2	.0586495	.0140393	4.18	0.000	.031034	.0862649
pillw3	.3640392	.1322946	2.75	0.006	.1038149	.6242636
defnw2	.0675316	.0228688	2.95	0.003	.0225485	.1125146
airw1	-.0597425	.0260616	-2.29	0.022	-.1110059	-.0084791
BSIposymp	1.016391	.5130903	1.98	0.048	.0071384	2.025643
BSItotal	-.8825938	.4771525	-1.85	0.065	-1.821156	.0559687
WHPpa	.6024789	.0757999	7.95	0.000	.4533799	.7515779
WHPsleep	.1079197	.0388074	2.78	0.006	.0315852	.1842541
PTSDw1	-.0213995	.0187859	-1.14	0.255	-.0583516	.0155526
crhtw1	-.8836272	1.444439	-0.61	0.541	-3.72485	1.957595
crhtw2	-2.823327	2.658753	-1.06	0.289	-8.053113	2.406459
crhtw3	4.610734	2.292071	2.01	0.045	.1022142	9.119254
icdx3nr3	-11.53809	4.923244	-2.34	0.020	-21.22215	-1.854036
icdx4nr9	22.39263	5.081201	4.41	0.000	12.39787	32.38738
_cons	-9.330052	4.349219	-2.15	0.033	-17.885	-.7751071

Trimmed Female social isolation main effects model

Linear regression

Number of obs	= 271
F(26, 270)	= 9.08
Prob > F	= 0.0000
R-squared	= 0.5435
Root MSE	= 13.946

(Std. Err. adjusted for 271 clusters in id)

whpsociso	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
age	1.038141	.6317541	1.64	0.101	-.2056492	2.281932
bcohort	-5.247071	3.117141	-1.68	0.093	-11.38406	.8899227
ncontw1	3.927036	1.833964	2.14	0.033	.3163475	7.537725
emplw13	11.3214	4.933582	2.29	0.023	1.608217	21.03458
emplw15	34.30502	15.45324	2.22	0.027	3.880851	64.72918
occ5w1	-8.705904	3.435755	-2.53	0.012	-15.47018	-1.941627
accdw2	7.356288	3.257395	2.26	0.025	.9431644	13.76941
shjobw1	.1537224	.0383864	4.00	0.000	.0781476	.2292971
shhlw1	-.1426786	.0358732	-3.98	0.000	-.2133054	-.0720518
trgovw2	.0631924	.0294526	2.15	0.033	.0052065	.1211784
injothr	-4.851527	2.513176	-1.93	0.055	-9.799441	.096386
polprw2	-.0694506	.0309748	-2.24	0.026	-.1304335	-.0084677
polprw3	-.1297427	.0593799	-2.18	0.030	-.2466493	-.0128361
airw1	.1222904	.054673	2.24	0.026	.0146508	.2299301
radw1	.0478414	.0268008	1.79	0.075	-.0049237	.1006066
radchw2	-.1833762	.0762393	-2.41	0.017	-.3334753	-.0332771
radchw3	.1695997	.0726062	2.34	0.020	.0266533	.312546
radtlw1	-.1206457	.0525757	-2.29	0.023	-.2241563	-.0171352
radtlw2	.1227053	.0658644	1.86	0.064	-.0069677	.2523783
BSIpsyc	1.838836	.5370801	3.42	0.001	.7814383	2.896233
BSIdep	.9352376	.4154888	2.25	0.025	.1172278	1.753247
BSIanx	-1.044706	.3680083	-2.84	0.005	-1.769237	-.3201753
whppa	.3122171	.072962	4.28	0.000	.1685704	.4558638
crhtw1	-.3210661	1.579522	-0.20	0.839	-3.430812	2.78868
crhtw2	-2.750958	3.861613	-0.71	0.477	-10.35366	4.851743
crhtw3	7.009435	3.295265	2.13	0.034	.5217539	13.49712
_cons	-41.49187	18.4753	-2.25	0.026	-77.86584	-5.117903

6.2 Potential moderators of buffers and stressors

Main effects can be moderated by interacting or moderating variables. We examine in Tables 4 through 6 those interactions which are not precluded from analysis by collinearity within the models. This list is not complete because statistical packages such as Stata will delete highly collinear effects, which commonly include main effects and their interactions. When a first-order interaction's main effects are dropped, the interaction is prevented from being estimated according to the conventional definition of the interaction, as being the joint effect over and above the individual main effects. Both the interaction and its main effects must be included for proper specification. If this precludes estimation, one of the parties to this joint effect will be omitted by the package, preventing proper estimation. We estimate those which do not suffer one of the components being deleted by the package. This means that some may actually exist that are not estimated. Nevertheless, interactions may span waves when they exhibit persistence or resilience. Even though they are statistically symmetrical, the ability to last beyond the length of a wave renders them worthy of note. Therefore, the interactions may occasionally appear between variables rooted in different waves.

The following tables represent the significant interactions that moderate the magnitude and direction of the main effect in the direction of their sign. The tables are listed according to wave, which refers to the summary score being tested. We have a summary score for males and females in each wave and the table designation indicates the wave and summary score for the endogenous variable in the left most column of the table. We have a male and female models for each Nottingham subscale score. The variable names of our summary scores are crhtw1, crhtw2, and crhtw3. The variable names are acronyms for Chornobyl related health threats in waves one, two, and three. When we construct an interaction with those summary scores, we use the variable name and then a X and then chtw“i”, where i indicates the wave under consideration. For example, diabetesXcht1 is an interaction between diabetes militus and the Chornobyl related health threat in wave one.

Table 4: Wave 1: Summary moderator effects of perceived Chornobyl risk impact on health

Nottinham Subscale score	**Male Models**	**Female Models**
Pain subscale	-	-
Physical ability	(diabetesXcht1 b= -16.859 p=0.004)	(retiredXcht1 b=26.83 p=0.000)
Social isolation	-	(retiredXcht1 b = 22.05 p=0.000)
Sleep	(strokeXcht1 b=312.724 p=0.001)	(icdx5nr7Xcht1 b= -150.95 p=0.00 (icdx4nr10Xcht1 b= -202.02 p=0.0 (occ5w3Xcht1 b= -27.701 p=0.002)
Energy level	(ageXcht1 b= -.444 p=-0.037) (whppaXcht1 b = .352 p=0.034)	-

```
Table 4 legend:
variable name          variable label

emplw15              retired
icdx3nr3             icdx3nr==diabetes militus
icdx4nr10            icdx4nr==varicose veins in legs
icdx5nr7             icdx5nr==angina pectoris
occ5w3               factory laborer machinist transp cleaner now
whppa                Nottingham physical ability pain subscale
```

Table 5: Wave 2: Summary moderator effects of perceived risk impact on health

Nottinham Subscale score	**Male Models**	**Female Models**
Pain subscale	(whppaXcrht2 b= -.673 p= 0.000)	-
Physical ability	(medcow1Xcht2 b= 0.708 p=.007)	(airw1Xcht2 b= -0.142 p=0.031)
Social isolation	-	(airw1Xcht2 b= -.135 p=0.021) (polprw2Xcht2 b= -.135, p=0.029)
Sleep	(strokeXcht2 b= -785.182 p=.000)	(occ5w3Xcht2 b= - 1012.671 p=0.001 (pillw2Xcht2 b= - 0.921 p=0.000)
Energy level	(ageXcht2 b=1.148 p=0.006) (BSIipsXcht2 b=7.467 p=0.006) (ecprw3Xcht2 b=3.94 p=.035) (fdferw1Xcht2 b=0.767 p=0.002)	(whppainXcht2 b=-0.673 p=0.006)

```
Table 5 legend
variable name     variable label

emplw25          retired
whppa            Nottingham physical ability pain subscale
whppain          Nottingham pain subscale
pillw2           number of pills for pain per week in 1987-1996
fdferw1          Level (in %) of fear of eating radioactively contaminated food
                   in 1986
medcow1         number of medical visits for a medical condition per year 1976-1986
airw1           consider hazardous (in percent) -air and water pollution in 1986
polprw2         consider hazardous (in percent) -political problems in 1996
ecprw3          consider hazardous (in percent) -economic problems, NOW
occ5w3          factory laborer machinist transp cleaner now
BSIips          Brief symptom invenstory interpersonal sensitivity subscale
icdx3nr7        icdx3nr==434.91 crbrl art ocl nos w infarc
```

Table 6: Wave 3: Summary of moderator effects of perceived risk and impact on health

Nottinham Subscale score	**Male Models**	**Female Models**
Pain subscale	(whppaXcrht3 b=0.681 p= 0.000)	(pillw3Xcrht3 b=.397 p=0.001) (crbrl art ocl w infrc X crht3 b=155.0 p= 0.007)
Physical ability	-	(polprw2Xcht3 b=0.139 p=0.042) (ageXcht3 b=0.499 p=0.000) (whpSocIsoXcht3 b=-0.688 p=0.000)
Social isolation	(varicose veinsXcht3 b=15.44 p=0.039)	-
Sleep	(strokeXcht3 b=482.32 p=0.000)	(whpPainXcht3 b=0.166 p=0.003) (icdx4nr10Xcht3 b= -202.025 p=0.000) (occ5w3Xcht3 b=1033.58 p=0.000)
Energy level	(BSIipsXcht3 b = -7.307 p=0.002) (fdferw1Xcht3 b= -0.749, p=0.000) (ecprw3Xcht3 b= .410 p=0.030)	(whppainXcht3 b=0.596 p=0.015)

Table 6 legend

variable name	variable label
whppa	Nottingham physical ability pain subscale
pillw3	number of pills for pain per week in 1997-now
icdx3nr7	icdx3nr==434.91 crbrl art ocl nos w infarc
polprw2	consider hazardous (in percent) -political problems in 1996
WHPsociso	Wtd Health Profile Social Isolation Pt 1 subscale
WHPpain	Wtd Health Profile Pain Pt 1 subscale
icdx4nr10	icdx4nr==varicose veins in legs
occ5w3	factory laborer machinist transp cleaner now
BSIips	Brief symptom inventory interpersonal sensitivity subscale
fdferw1	Level (in %) of fear of eating radioactively contaminated food in 1986
ecprw3	consider hazardous (in percent) -economic problems, NOW
icdx4nr10	icdx4nr==varicose veins in legs

6.3 Potential indirect paths

A total effect is the sum of the direct, indirect, and spurious effects. We try to minimize the potential for spuriousness by controlling for all potential confounders, which is a great advantage that AutoMetrics brings to the table. It identifies those variables likely to be covariates that we may not have thought of. To assess the total effect of one variable on an endogenous variable, the sum of the indirect paths should be taken into consideration. When we embark on our final path modeling, we will endeavor to take those things into account. For the time being, we merely take note of some of the possible indirect paths which may lend themselves to real effects although they are not direct.

For an indirect path to exist, all of the links between the first and the ultimate endogenous variable must be statistically significant. For example, if x leads to w and w leads to y, then b_{wx} and b_{yw} must both be statistically significant for the indirect path to be a significant mediating path. In Tables 7 through 9, we list variables through which such paths do exist, without the presence of other confounding factors, and which paths we will ultimately test in the construction of our etiological path model.

Legend for Mediating variables

variable name	storage type	display format	value label	variable label
whpsociso	float	%9.0g		Nottingham social isolation subscale
whpsleep	float	%9.0g		Nottimnghame sleep subscale
whppa	float	%9.0g		
whpel	float	%9.0g		Nottingham energy level subscale
whppain	float	%9.0g		
BSItotal	double	%9.0g		Basic symptom inventory total scale score
BSIposymp	double	%9.0g		Brief Symptom inventory positive symptom total subscale
BSIdep	double	%9.0g		Basic symptom inventory Depression subscale
BSIsoma	double	%9.0g		Basic symptom inventory obsessive compulsive subscale

Table 7: Wave 1: Possible intervening variables providing indirect paths

Nottinham Subscale score	**Male Models**	**Female Models**
Pain subscale	age BSItotal BSIposymp whpsleep whppa hypertension diabetes militus	age whppa sleep
Physical ability	age whppain medcow1 BSIanx BSIsoma BSIdep	age BSIsoma social isolatn medcow1 bcohort
Social isolation	age BSIanx BSIdep	age whpa BSIanx retiredXcht2 polprw2Xcht2 airw1Xcht2
Sleep	age shrelaw1 illw1 whppain BSIposymp shrelaw2 stroke	age BSIanx HP2probsoc
Energy level	age whppa whpsleep BSItotal BSIposymp BSIips BSIhos Hp2pbfhm fdferw1 hypertension	age BSIanx HP2pbfhm sleep social isolatn marrw11 marrw13 marrw16 marrw21 marrw26

Table 8: Wave 2: Possible intervening variables providing indirect paths

Nottinham Subscale score	**Male Models**	**Female Models**
Pain subscale	age BSItotal BSIposymp whppa whpsleep diabetes hypertension	age sleep whppa BSItotal BSIposymp nutritional deficiency
Physical ability	age BSIsoma BSIdep BSIanx whppain medcow1 physdisagw2 diabetes militus	age BSIsoma BSIpsyc single social isolatn whppain medcow1 birth cohort
Social isolation	age BSIdep BSIips BSIphanx	age emplw25 whppa BSIpsyc BSIanx BSIdep retiredXcht2
Sleep	age stroke illw1 illw3 whppain BSIposymp shrelaw2 shrelaw1 stroke	age whppain BSIanx HP2probsoc BSIposymp BSItotal BSIdep BFdepx1
Energy level	age whppa whpsleep BSItotal BSIposymp BSIips BSIhos Hp2pbfhm radw2 hypertension PTSDw2	age marrw21 marrw25 marrw26 BSIposymp BSIanx BSIips plthw3 PTSDw2 whppain social isolatn sleep HP2pbfhm

Table 9: Wave 3: Possible intervening variables providing indirect paths

Nottinham Subscale score	Male Models	Female Models
Pain subscale	age BSItotal BSIposymp whppa whpsleep diabetes hypertension defnew2 stroke retired	age sleep whppa BSUtotal BSIposymp Chornbl support2
Physical ability	age BSIsoma BSIdep whppain diabetes militus medcow1 illw3 physdisagw2	age BSIsoma BSIpsyc single social isolatn whppain medcow1 birth cohort
Social isolation	age BSIdep BSIips BSIphanx	age illw3 whppa whpel BSIanx BSIdep BSIsoma BSIpsyc social isolatn whppain single medcow1 retiredXcht2
Sleep	age illw3 whppain BSIposymp shrelaw2 icd3nr7 (storke)	age whppain BSIanx HP2probsoc BSIposymp BSItotal BSIdep BFdepx1
Energy level	age whppa whpsleep BSItotal BSIposymp BSIips BSIhos Hp2pbfhm hypertension ecprw3	age BSItotal BSIposymp BSIips BSIanx phlthw3 PTSDw2 whppain social isolatn sleep HP2pbfhm

```
BSIips          double %9.0g                  Basic symptom invenstory
                                                interpersonal sensitivity
                                                subscale
BSIphanx        double %9.0g                  Basic symptom inventory phobic
                                                anxiety subscale
BSIhos          double %9.0g                  Basic symptom invenstory
                                                hostility subscale
fdferw1         double %8.0g                * Level (in %) of fear of eating
                                                radioactively contaminated food
                                                in 1986
illw1           double %8.0g                  Total number of illnesses
                                                experienced in time period
                                                1976-1986
illw2           double %8.0g                  Total number of illnesses
                                                experienced in time period
                                                1987-1996
illw3           double %8.0g                  Total number of illnesses
                                                experienced in time period
                                                1996-NOW
radw1           double %8.0g                  believed % of the radioactively
                                                contaminated area in 1986
radw2           double %8.0g                  believed % of the radioactively
                                                contaminated area in 1996
radw3           double %8.0g                  believed % of the radioactively
                                                contaminated area NOW
marrw11         byte   %8.0g                  marrw1==1. single
marrw12         byte   %8.0g                  marrw1==2. cohabitating
marrw13         byte   %8.0g                  marrw1==3. married
marrw14         byte   %8.0g                  marrw1==4. separated
marrw15         byte   %8.0g                  marrw1==5. divorced
marrw16         byte   %8.0g                  marrw1==6. widowed
marrw21         byte   %8.0g                  marrw2==1. single
marrw22         byte   %8.0g                  marrw2==2. cohabitating
marrw23         byte   %8.0g                  marrw2==3. married
marrw24         byte   %8.0g                  marrw2==4. separated
marrw25         byte   %8.0g                  marrw2==5. divorced
marrw26         byte   %8.0g                  marrw2==6. widowed
medcow1         double %8.0g                  number of medical visits for a
                                                medical condition per year
                                                1976-1986
physdisagw2     double %9.0g                  Average Physical Discomfort level
                                                in percent in wave 2
emplw25         double %8.0g                  emplw2==4. retired
bcohort         float  %17.0g      bc5        Birth cohort (5 year) span except
                                                boundary spans
airw1           double %8.0g                  consider hazardous (in percent) -
                                                air and water pollution in 1986
illw1           double %8.0g                  Total number of illnesses
                                                experienced in time period
                                                1976-1986
shrelaw1        double %8.0g                  Percentage of strains and hassles
                                                related to relationships in
                                                1986
shrelaw2        double %8.0g                  Percentage of strains and hassles
                                                related to relationships in
                                                1996
HP2pbfhm        double %9.0g       hp2fmt     Hlth profile Pt2: Hlth causing
                                                probs with family members at
                                                home
BFdepx1         float  %9.0g                   max(0, WHPer + 3.14933e-007)
PTSDw1          double %9.0g                  Average PTSD level in percent in
```

```
                                                    wave 1
PTSDw2          double %9.0g                      Average PTSD level in percent in
                                                    wave 2
PTSDw3          double %9.0g                      Average PTSD level in percent in
                                                    wave 3
defnw2          double %8.0g                    * consider hazardous (in percent) -
                                                    deficiencies in essential
                                                    nutrition in 1996
```

The indirect paths may exhibit persistence by showing that an indirect path can go through the next wave to an endogenous variable that is not wave specific. We will discuss our findings regarding our hypothesis tests. Then we will discuss their reliability, depending upon whether we used the GETS procedure or the mixed MARS and AutoMetrics procedure. Cross wave indirect paths indicate persistence of a health problem.

6.4 Hypothesis tests

For this hypothesis, we find that the summary perceived Chornobyl health threat score is only statistically related to retrospectively to pain in wave one in a wave three model and with respect to isolation on the part of women in wave three. Other direct effects do not appear to be reliable when potential confounders are controlled for in these equations.

6.5 Directions for future exploration

We will explore these alternative paths in further analysis.

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