A path analysis of substance abuse among Ukrainian residents after Chornobyl- Hypotheses 12, 16, 20, & 24

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1) Robert Alan Yaffee 2) RoseMarie Perez Foster
3) Thomas B. Borak 3) Remi J. Frazier
4) Mariya Burdina 5) Victor Chtenguelov
and 6) Gleb Prib

Affiliations:

1) Silver School of Social Work, New York University, New York, New York
2) Natural Hazards Center, University of Colorado at Boulder
3) Environmental and Radiological Health Sciences,
Colorado State University, Fort Collins, Colorado
4) Department of Economics and International Business,
University of Central Oklahoma, Edmond, Oklahoma
5) Deputy Director, Ukrainian Institute on Public Health Policy , Kiev, Ukraine
6) Applied Psychology, Academy of Labor and Social Relations, Kiev, Ukraine

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1 Acknowledgements

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2 Introduction

2.0.1 The area surveyed

In this analysis, we examine alcohol and smoking abuse, along with abortions after the Chornobyl incident among residents. The residents comprising respondents to our survey lived in either Kiev or Zhitomyr Oblasts. The Chornobyl nuclear plant was located near Pripyat in the Oblast of Kiev and Zhitomyr was the adjacent Oblast to its west. Respondents were selected from a random generation of phone numbers which were attached to the area codes for the raions and cities in both the Kiev and Zhitomyr Oblasts provided by the Ukrainian telephone company. Approximately 14% of the randomly generated numbers were actual phone numbers assigned. Respondents who failed to answer at first were given up to four call backs before the number was discarded and the next one tried. Willing respondents were paid a nominal sum for their time after an interview was completed at their home at a mutually convenient time. Only those who agreed voluntarily were interviewed.

The data were recorded on laptop computers and, after an independent auditing group confirmed that the responses were completely voluntary and offered with the consent of the respondents, was the data uploaded to the Vovici company whose personnel input the data into a computer file.

2.0.2 Hypotheses being tested

To address hypotheses 12 and 16, which relate to the relationship between radiation dose and perceived risk of exposure on the one hand, and substance abuse on the part of both men and women, we operationalized these hypotheses by constructing several scales. Hypothesis 12 submits that radiation dose directly predicts substance abuse. Hypothesis 16 maintains that perceived risk of exposure directly predicts substances abuse.

Similarly, Hypothesis 20 suggests that radiation dose indirectly predicts, which here means indirectly explains, through a mediator of Nottingham scale measures. The Nottingham measures that we use for this general rubric are the measures for sleep, energy level, and physical ability.

Hypothesis 24 submits that perceived risk of exposure to radiation predicts substances abuse through the mediator of the Nottingham health scale and

subscales.

2.0.3 Hypothesis operationalization

We define the terms in these hypotheses according to testable items and scales.

We operationalize radiation dose as external radiation dose with the cumulative external dose in milliGrays. These variables are respectively called cumdose1, cumdose2, and cumdose3, with the numeric suffix indicating the wave in which they were measured. These measures were reconstructed cumulative external doses to which the respondents were exposed.

We define substance abuse as nicotine and alcohol abuse. To measure nicotine abuse, we used a measure that asked how many cigarettes a week a person smoked in 1985, and this was called smokww0, which served as a baseline for comparison with subsequent counts. The number of cigarettes smoked per week in 1986 was called smokww1. The number of cigarettes smoked per week during wave 2, extending from 1987 through the end of 1996, was called smokww2. The number of cigarettes per week smoked from 1997 through 2006, was called smokww3, whereas the weekly smoke rate from there to the time of the interview was called smokww4. The interviews began in 2009 and ended in 2011.

Alcohol abuse was computed by adding together the number of vodka drinks per week a person consumed with the number of beer or wine drinks per week that he had. Together this was called alcuseww. The numeric suffix matched the waves smoking time periods used for cigarette smoking.

The instrument used to assess the Chornobyl related health risk was comprised of factor scores of three variables, the percent to which one thought his or her health had been affected by Chornobyl, the percent to which the respondent thought that the family health had been affected by Chornobyl, and the proportion of cancer cases in the Zhitomyr and Kiev Oblasts which were products of the Chornobyl disaster. The alpha reliabilities of these perceived risk scales are contained in Table 1. To render this measure wave specific, we computed this score separately for each wave of our study.

Table 1: Alpha reliabilities of Chornobyl related health risk scales

Wave	**Scale**
1	crhrw1 = 0.726
2	crhrw2 = 0.822
3	crhrw3 = 0.834

3 Path analysis

We employed a robust path analysis to test several of our hypotheses. Hypothesis 9 postulates that radiation dose directly explains the number of abortions,

Table 2: Alpha reliabilities of male Nottingham health scales

Gender	**Scale**
male	whpsleep = 0.721
male	whpel = 0.613
male	whppa = 0.789

which issue is addressed in the female model. Hypothesis 12 maintains that radiation dose directly explains or predicts substance abuse is addressed in both the male and female models as is Hypothesis 16, which postulates that perceived risk directly predicts substance abuse.

Model building with full-information maximum likelihood can be complex with large models. Model building entails testing sundry plausible alternative paths between variables and pruning out paths that appear to be not statistically significant. Because changing one path can change all paths, model fitting is done on the basis of a global fit index. When the model comprising significant paths is not inconsistent with the data, the likelihood ratio χ^2 for the number of degrees of freedom identifying those paths minus the constraints, will no longer be statistically significant. A model may not unique. Depending on the variables in the model, it is possible for several combinations of paths to provide a fit. The one that offers the best fit is usually deemed the optimal model, if the paths correspond to theoretical reality. However, such model building usually proceeds non-optimally from specific-to-general.

4 Assumptions and Model structure

We rely on the same assumptions and model structure explained in our Hypothesis 4 and 5 discussion on path models. Owing to sample size limitations in structural equation models and the large number of variables required for our hypothesis testing, we do not use measurement models in the robust structural path analysis.

Path models generally assume unidirectional causality, unless arrows from two variables point to one another, in which case, the model assumes that the index of stability is less than one. In short, there is no reverse causality. If is a feedback loop in the presumed causal structure, the model must be identified for the parameters to be uniquely estimable.

We should add however that path analysis assumes a closed system, that all of the relevant variables are in the model. If there is a missing variable, it could be an antecedent variable between two of the key variables in the model, which could generate a spurious relationship on which much of the model is then based. I that case, a large portion of the model could be predicted on a spurious basis, leading to all kind of erroneous conclusions. Specification error or omitted variable bias can propagate other biases throughout a model. For

this reason, we will perform some auxiliary regressions to show that any variable not included in the model does not pose such a threat.

5 Model estimation

We had originally planned on estimating our models with OLS or two-stage least squares (TSLS). However, we use maximum likelihood estimation where we can rather than two stage least squares (TSLS) for several reasons. Although TSLS may outperform ML in small samples, we have large samples in our analysis. Although TSLS are not unbiased in finite samples, it is consistent. Maximum likelihood estimation is also biased for finite samples, but is preferred because it is consistent, invariant to reparameterization, computable, asymptotically normal, as well as asymptotically more efficient because it uses all of the information available. ML can outperform TSLS in obtaining asymptotically efficient estimates and can also be used for nonlinear applications if observations are independent and identically distributed as well as asymptotically symmetric, as long as they are not on the boundaries of the parameter space [1, 108], [3, 245-247,253-258]. More importantly if there are autoregressive errors in the model, which are common with repeated measures, ML can provide an estimate that is stationary [3, 347], which in this case is necessary. To be sure that this condition is satisfied, we test the stability index and find that it is less than unity (stability index = 0.0006), indicating that the modulus of the largest eigenvalue satisfies the stability conditions.

6 Male model

In Figure 1, the path diagram depicts statistically significant interrelated paths. Table 3 presents the model output that is depicted in the figure and 4 presents their robust effects. Tables 5, 6, and 7 present respectively their direct, indirect, and total effects. From this figure and these tables we can test the hypothesis 12, 16, 20, and 24 for the male subsample.

Figure 1 is color-coded to aid interpretation of the paths. Cumulative external radiation dose have a rose-colored fill and red arrows emanating from them to designate their direct effects. Chornobyl related health risk variables are boxes that have an orange color filling the rectangle with magenta arrows emanating from them. Age of the respondent is colored with a gold fill and has black arrows emanating from it. Alcohol abuse for males is light blue colored with blue arrows projecting from them, while cigarette smoking variables are represented by stone colored boxes with sienna colored arrows coming from them. The Nottingham energy level measure is mint colored, the Nottingham variable for sleeping issues is grey with a gray arrows projecting from it, while the Nottingham physical ability variable is colored cyan with a bright blue arrow extending from it.

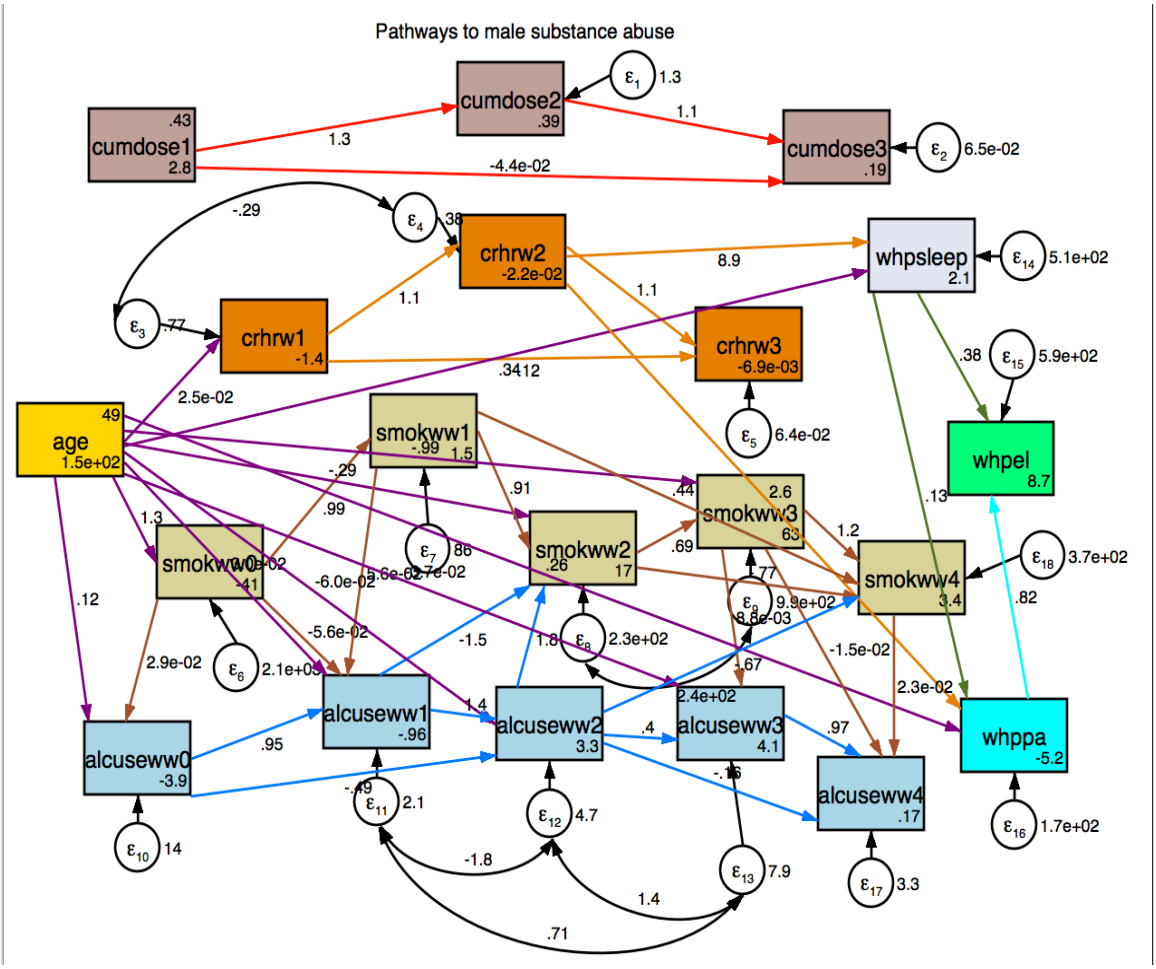

Figure 1: Pathways to substance abuse among male respondents

7 Pathways to Male substance abuse

The model exhibits both respectable the omnibus goodness of fit and its stability as a dynamic model. We then address the model in relation to hypothesis 12, which postulates that radiation directly substance abuse. Next, we turn to a discussion of it in relation to hypothesis 16, which submits that perceived exposure risk directly predicts substance abuse. We not only discuss a strict interpretation of these hypotheses, but a broader one as well, where we consider indirect and total effects.

The model fits the data well. The model is fitted with conventional standard errors, for goodness of fit statistics are not available for robust models. Once the model is fit and the goodness of fit criteria are satisfied, we proceed to compute the robust estimates which control for heteroskedasticity and serial correlation. We take the standardized version of those and assess the paths with this version. After the model is fit, there appears to be no statistically significant difference between the global model and the data as indicated by LR test of model vs. saturated: $\chi^2(142) = 160.79, Prob > \chi^2 = 0.1338$.

The stability index = .00366, which is smaller than one, indicating that the model satisfies the conditions for stability of the model. We can now turn to the hypothesis testing of direct effects. The parameter estimates contained in Figure 1 can be found in Table 3. The clustered-robust estimates which we use for our analysis can be found in Table 4. Their decomposition into direct, indirect, and total effects is contained in the following three tables. We turn to Table 5 now to examine the direct effects with which we begin the hypothesis testing.

Table 3 Pathways to male substance abuse

Endogenous variables

Observed: crhrw1 smokww0 smokww2 smokww3 alcuseww0 alcuseww1 alcuseww2 alcuseww3 whpsleep whppa cumdose2 cumdose3 crhrw2 crhrw3 smokww1 smokww4 alcuseww4 whpel

Exogenous variables

Observed: age cumdose1

Structural equation model Number of obs = 339
Estimation method = ml
Log likelihood = -18875.539

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
crhrw1 <-						
age	.0246239	.0039032	6.31	0.000	.0169737	.0322741
_cons	-1.352975	.1977762	-6.84	0.000	-1.740609	-.9653407
smokww0 <-						
age	1.326173	.2059833	6.44	0.000	.9224532	1.729893
_cons	-40.85341	10.43717	-3.91	0.000	-61.30988	-20.39694
smokww2 <-						
alcuseww1	-1.542619	.3831784	-4.03	0.000	-2.293635	-.7916029
alcuseww2	1.813447	.392575	4.62	0.000	1.044014	2.582879
smokww1	.9079972	.0185832	48.86	0.000	.8715748	.9444195
age	-.2878197	.0770508	-3.74	0.000	-.4388366	-.1368029
_cons	17.20474	3.726329	4.62	0.000	9.901269	24.50821
smokww3 <-						
smokww2	.6902071	.0400846	17.22	0.000	.6116427	.7687715
age	-.9921297	.1436319	-6.91	0.000	-1.273643	-.7106164
_cons	63.00692	7.109409	8.86	0.000	49.07274	76.94111
alcus~0 <-						
smokww0	.0289879	.0043454	6.67	0.000	.0204711	.0375048
age	.1184784	.0174588	6.79	0.000	.0842599	.152697
_cons	-3.87734	.8537152	-4.54	0.000	-5.550591	-2.204089
alcus~1 <-						
smokww0	-.0557084	.0083612	-6.66	0.000	-.0720961	-.0393207
alcuseww0	.9468597	.0209001	45.30	0.000	.9058964	.9878231
smokww1	.0560992	.0085196	6.58	0.000	.0394011	.0727973
age	.0298429	.0072293	4.13	0.000	.0156737	.0440121
_cons	-.9554637	.3437604	-2.78	0.005	-1.629222	-.2817057

Continued...

Table 3 continued...

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
alcus~2 <-						
alcuseww0	-.4905034	.2189687	-2.24	0.025	-.9196743	-.0613326
alcuseww1	1.383275	.2270225	6.09	0.000	.9383188	1.828231
age	-.059802	.0122919	-4.87	0.000	-.0838937	-.0357103
_cons	3.268085	.5372383	6.08	0.000	2.215117	4.321053
alcus~3 <-						
smokww3	.0087797	.0030067	2.92	0.003	.0028867	.0146727
alcuseww2	.3977046	.0462957	8.59	0.000	.3069666	.4884426
age	-.0370357	.0136027	-2.72	0.006	-.0636966	-.0103749
_cons	4.074786	.664613	6.13	0.000	2.772169	5.377404
whpsl~p <-						
crhrw2	8.854608	1.430654	6.19	0.000	6.050578	11.65864
age	.3424499	.1077473	3.18	0.001	.131269	.5536307
_cons	2.137575	5.538516	0.39	0.700	-8.717717	12.99287
whppa <-						
whpsleep	.1312072	.0312076	4.20	0.000	.0700413	.192373
crhrw2	2.58612	.8672467	2.98	0.003	.8863481	4.285892
age	.2621885	.0628266	4.17	0.000	.1390507	.3853262
_cons	-5.180545	3.183096	-1.63	0.104	-11.4193	1.058208
cumdo~2 <-						
cumdose1	1.339597	.0366997	36.50	0.000	1.267667	1.411527
_cons	.3879549	.0632438	6.13	0.000	.2639992	.5119105
cumdo~3 <-						
cumdose2	1.087217	.0123079	88.34	0.000	1.063094	1.11134
cumdose1	-.0439337	.0184663	-2.38	0.017	-.080127	-.0077403
_cons	.1920846	.0151063	12.72	0.000	.1624768	.2216924

Continued...

Table 3 continued...

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
crhrw2 <-						
crhrw1	1.140574	.111028	10.27	0.000	.9229633	1.358185
_cons	-.0219108	.0369507	-0.59	0.553	-.0943329	.0505113
crhrw3 <-						
crhrw1	-.1183935	.0256569	-4.61	0.000	-.1686801	-.0681068
crhrw2	1.055212	.0258798	40.77	0.000	1.004489	1.105936
_cons	-.0069225	.0140543	-0.49	0.622	-.0344684	.0206233
smokww1 <-						
smokww0	.9937766	.0102284	97.16	0.000	.9737293	1.013824
_cons	1.467235	.5606438	2.62	0.009	.368393	2.566076
smokww4 <-						
smokww2	-.7728833	.0930455	-8.31	0.000	-.9552491	-.5905175
smokww3	1.217832	.0372666	32.68	0.000	1.144791	1.290873
alcuseww2	-.6730745	.2769663	-2.43	0.015	-1.215918	-.1302305
smokww1	.43886	.0714728	6.14	0.000	.2987759	.5789441
_cons	3.404897	1.483691	2.29	0.022	.4969169	6.312878
alcus~4 <-						
smokww3	-.0154824	.0047969	-3.23	0.001	-.0248842	-.0060806
alcuseww2	-.1600712	.0311518	-5.14	0.000	-.2211276	-.0990149
alcuseww3	.9678354	.0353726	27.36	0.000	.8985064	1.037164
smokww4	.0231128	.0046173	5.01	0.000	.0140631	.0321625
_cons	.1722175	.1564103	1.10	0.271	-.1343411	.4787762
whpel <-						
whpsleep	.3823403	.0566125	6.75	0.000	.2713818	.4932988
whppa	.8244046	.096586	8.54	0.000	.6350996	1.01371
_cons	8.713145	1.703305	5.12	0.000	5.374728	12.05156

Continued...

Table 3 continued...

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Variance						
e.crhrw1	.7713972	.0592507			.6635867	.8967233
e.smokww0	2148.302	165.0101			1848.056	2497.329
e.smokww2	230.9568	17.78794			198.597	268.5895
e.smokww3	992.3757	78.52164			849.8159	1158.85
e.alcuse~0	13.75178	1.056267			11.82983	15.98598
e.alcuse~1	2.096951	.1613344			1.803428	2.438247
e.alcuse~2	4.689318	.903932			3.213873	6.842121
e.alcuse~3	7.897784	.6450639			6.729488	9.268906
e.whpsleep	506.0748	38.87137			435.3458	588.295
e.whppa	167.0846	12.83369			143.7329	194.2302
e.cumdose2	1.271465	.0976606			1.093765	1.478035
e.cumdose3	.0652934	.0050152			.056168	.0759014
e.crhrw2	.3784514	.0698617			.2635598	.5434268
e.crhrw3	.0643684	.0049441			.0553723	.0748261
e.smokww1	85.50906	6.567911			73.55831	99.40141
e.smokww4	369.4726	28.37902			317.8351	429.4995
e.alcuse~4	3.345888	.2569961			2.878267	3.889483
e.whpel	585.7827	44.9937			503.9137	680.9527
Covariance						
e.crhrw1 e.crhrw2	-.2860853	.0918583	-3.11	0.002	-.4661243	-.1060462
e.smokww2 e.smokww3	235.2082	30.57052	7.69	0.000	175.2911	295.1254
e.alcuse~1 e.alcuse~2	-1.8132	.5180716	-3.50	0.000	-2.828602	-.7977988
e.alcuse~1 e.alcuse~3	.7136311	.2312889	3.09	0.002	.2603132	1.166949
e.alcuse~2 e.alcuse~3	1.405882	.3840137	3.66	0.000	.6532295	2.158535

LR test of model vs. saturated: chi2(142) = 160.79, Prob > chi2 = 0.1338

Stability analysis of simultaneous equation systems

stability index = .003657
All the eigenvalues lie inside the unit circle.
SEM satisfies stability condition.

7.1 Direct effects on Substance Abuse among males

7.1.1 Hypothesis 12: Direct dose effects on male substance abuse

Hypothesis 12 submits that radiation dose directly predicts or explains the substance abuse. When we examine the clustered-robust direct effects estimates in Table 5 on page 15, 16, and 17 we find no direct effects originating with cumulative external dose under any of the male alcohol abuse or smoking abuse panels, which suggests that we do not find supporting evidence for a direct effect of cumulative external dose with respect to male substance abuse. Hypothesis 12

is not confirmed by our model or data.

7.1.2 Hypothesis 16: Direct perceived risk effects on male substance abuse

Hypothesis 16 postulates direct effects of perceived risk of exposure on male substance abuse. If we turn to Table 5 on page 15 and 16, we can examine the several panels of smoking and alcohol abuse to discover any significant direct effects of perceived risk. But we find no evidence of direct effects impacting any alcoholic (alcuseww0 through alcuseww4) or nicotine (smokww0 through smokww4) substance abuse originating from perceived risk of exposure to Chornobyl radiation. In short, we find no evidence to support hypothesis 16 either.

Table 4 Clustered-robust effects among males

Endogenous variables

Observed: crhrw1 smokww0 smokww2 smokww3 alcuseww0 alcuseww1 alcuseww2
           alcuseww3 whpsleep whppa cumdose2 cumdose3 crhrw2 crhrw3 smokww1
           smokww4 alcuseww4 whpel

Exogenous variables

Observed: age cumdose1

Fitting target model:
Structural equation model   Number of obs   =   339
Estimation method = ml
Log pseudolikelihood= -18875.539

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

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
crhrw1 <-						
age	.0246239	.0038517	6.39	0.000	.0170748	.032173
_cons	-1.352975	.1933159	-7.00	0.000	-1.731867	-.9740827
smokww0 <-						
age	1.326173	.1899903	6.98	0.000	.9537989	1.698547
_cons	-40.85341	7.827981	-5.22	0.000	-56.19597	-25.51085
smokww2 <-						
alcuseww1	-1.542619	.6531179	-2.36	0.018	-2.822706	-.2625312
alcuseww2	1.813447	.6263327	2.90	0.004	.585857	3.041036
smokww1	.9079972	.0251069	36.17	0.000	.8587886	.9572058
age	-.2878197	.0623285	-4.62	0.000	-.4099813	-.1656581
_cons	17.20474	3.385673	5.08	0.000	10.56894	23.84054
smokww3 <-						
smokww2	.6902071	.0551092	12.52	0.000	.582195	.7982192
age	-.9921297	.1319737	-7.52	0.000	-1.250793	-.7334659
_cons	63.00692	7.628081	8.26	0.000	48.05616	77.95769
alcus~0 <-						
smokww0	.0289879	.0073173	3.96	0.000	.0146463	.0433296
age	.1184784	.0197675	5.99	0.000	.0797348	.1572221
_cons	-3.87734	.8331105	-4.65	0.000	-5.510206	-2.244473
alcus~1 <-						
smokww0	-.0557084	.0191486	-2.91	0.004	-.093239	-.0181778
alcuseww0	.9468597	.0198926	47.60	0.000	.9078709	.9858486
smokww1	.0560992	.0195746	2.87	0.004	.0177337	.0944647
age	.0298429	.0112082	2.66	0.008	.0078752	.0518105
_cons	-.9554637	.4523497	-2.11	0.035	-1.842053	-.0688746

Continued on the next page...

Table 4 Robust Model output continued:

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
alcus~2 <-						
alcuseww0	-.4905034	.2889307	-1.70	0.090	-1.056797	.0757903
alcuseww1	1.383275	.3025218	4.57	0.000	.7903429	1.976207
age	-.059802	.0164137	-3.64	0.000	-.0919722	-.0276318
_cons	3.268085	.6476422	5.05	0.000	1.998729	4.53744
alcus~3 <-						
smokww3	.0087797	.0034586	2.54	0.011	.002001	.0155585
alcuseww2	.3977046	.1322344	3.01	0.003	.13853	.6568792
age	-.0370357	.0184954	-2.00	0.045	-.0732861	-.0007854
_cons	4.074786	.6896206	5.91	0.000	2.723155	5.426418
whpsl~p <-						
crhrw2	8.854608	1.397842	6.33	0.000	6.114889	11.59433
age	.3424499	.1134367	3.02	0.003	.1201181	.5647817
_cons	2.137575	5.759954	0.37	0.711	-9.151727	13.42688
whppa <-						
whpsleep	.1312072	.0402968	3.26	0.001	.0522268	.2101875
crhrw2	2.58612	.7967575	3.25	0.001	1.024504	4.147736
age	.2621885	.0657718	3.99	0.000	.1332781	.3910988
_cons	-5.180545	3.075157	-1.68	0.092	-11.20774	.8466515
cumdo~2 <-						
cumdose1	1.339597	.2873117	4.66	0.000	.7764767	1.902718
_cons	.3879549	.0833225	4.66	0.000	.2246458	.5512639
cumdo~3 <-						
cumdose2	1.087217	.0775735	14.02	0.000	.9351758	1.239258
cumdose1	-.0439337	.0846185	-0.52	0.604	-.2097829	.1219155
_cons	.1920846	.0309996	6.20	0.000	.1313266	.2528426
crhrw2 <-						
crhrw1	1.140574	.1089308	10.47	0.000	.9270738	1.354075
_cons	-.0219108	.0369236	-0.59	0.553	-.0942797	.0504581
crhrw3 <-						
crhrw1	-.1183935	.0379136	-3.12	0.002	-.1927027	-.0440842
crhrw2	1.055212	.0329604	32.01	0.000	.990611	1.119814
_cons	-.0069225	.0143437	-0.48	0.629	-.0350358	.0211907
smokww1 <-						
smokww0	.9937766	.0068764	144.52	0.000	.9802992	1.007254
_cons	1.467235	.5601348	2.62	0.009	.3693906	2.565079

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Table 4 Robust Model output continued:

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
smokww4 <-						
smokww2	-.7728833	.1605092	-4.82	0.000	-1.087476	-.458291
smokww3	1.217832	.0508214	23.96	0.000	1.118224	1.31744
alcuseww2	-.6730745	.3464082	-1.94	0.052	-1.352022	.0058731
smokww1	.43886	.1233524	3.56	0.000	.1970937	.6806263
_cons	3.404897	1.456104	2.34	0.019	.5509866	6.258808
alcus~4 <-						
smokww3	-.0154824	.0065657	-2.36	0.018	-.028351	-.0026138
alcuseww2	-.1600712	.0598169	-2.68	0.007	-.2773102	-.0428323
alcuseww3	.9678354	.0651211	14.86	0.000	.8402003	1.09547
smokww4	.0231128	.0071052	3.25	0.001	.0091869	.0370387
_cons	.1722175	.2003617	0.86	0.390	-.2204841	.5649192
whpel <-						
whpsleep	.3823403	.0643539	5.94	0.000	.2562089	.5084717
whppa	.8244046	.1029768	8.01	0.000	.6225737	1.026236
_cons	8.713145	1.515674	5.75	0.000	5.742478	11.68381
Variance						
e.crhrw1	.7713972	.0411147			.69488	.8563401
e.smokww0	2148.302	287.8646			1652.105	2793.53
e.smokww2	230.9568	43.97401			159.024	335.4277
e.smokww3	992.3757	129.3514			768.6455	1281.227
e.alcuse~0	13.75178	3.152807			8.774203	21.55311
e.alcuse~1	2.096951	.5395064			1.266456	3.472055
e.alcuse~2	4.689318	1.511838			2.492769	8.821398
e.alcuse~3	7.897784	1.600735			5.308629	11.74974
e.whpsleep	506.0748	56.21737			407.0605	629.1736
e.whppa	167.0846	22.15425			128.8466	216.6705
e.cumdose2	1.271465	.8062854			.3668804	4.406405
e.cumdose3	.0652934	.0299735			.0265533	.1605537
e.crhrw2	.3784514	.0870449			.2411189	.5940034
e.crhrw3	.0643684	.0182932			.0368779	.1123517
e.smokww1	85.50906	37.72548			36.01415	203.0258
e.smokww4	369.4726	66.28407			259.9412	525.1573
e.alcuse~4	3.345888	.7910341			2.10509	5.318049
e.whpel	585.7827	52.64943			491.1698	698.6208
Covariance						
e.crhrw1						
e.crhrw2	-.2860853	.097132	-2.95	0.003	-.4764604	-.0957101
e.smokww2						
e.smokww3	235.2082	41.12941	5.72	0.000	154.5961	315.8204
e.alcuse~1						
e.alcuse~2	-1.8132	.8925951	-2.03	0.042	-3.562655	-.0637462
e.alcuse~3	.7136311	.3295918	2.17	0.030	.067643	1.359619
e.alcuse~2						
e.alcuse~3	1.405882	.3763966	3.74	0.000	.6681587	2.143606

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Table 5 Clustered-robust Direct effects on substance abuse among males
(Std. Err. adjusted for 339 clusters in id)

Direct effects

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
Structural					
crhrw1 <-					
age	.0246239	.0038517	6.39	0.000	.3241375
smokww0 <-					
age	1.326173	.1899903	6.98	0.000	.3300796
smokww2 <-					
smokww0	0	(no path)			0
alcuseww0	0	(no path)			0
alcuseww1	-1.542619	.6531179	-2.36	0.018	-.1517836
alcuseww2	1.813447	.6263327	2.90	0.004	.1576793
smokww1	.9079972	.0251069	36.17	0.000	.9664959
age	-.2878197	.0623285	-4.62	0.000	-.0753884
smokww3 <-					
smokww0	0	(no path)			0
smokww2	.6902071	.0551092	12.52	0.000	.6670585
alcuseww0	0	(no path)			0
alcuseww1	0	(no path)			0
alcuseww2	0	(no path)			0
smokww1	0	(no path)			0
age	-.9921297	.1319737	-7.52	0.000	-.2511521
alcus~0 <-					
smokww0	.0289879	.0073173	3.96	0.000	.3245414
age	.1184784	.0197675	5.99	0.000	.3301495
alcus~1 <-					
smokww0	-.0557084	.0191486	-2.91	0.004	-.5958264
alcuseww0	.9468597	.0198926	47.60	0.000	.904549
smokww1	.0560992	.0195746	2.87	0.004	.6068846
age	.0298429	.0112082	2.66	0.008	.0794435
alcus~2 <-					
smokww0	0	(no path)			0
alcuseww0	-.4905034	.2889307	-1.70	0.090	-.5302548
alcuseww1	1.383275	.3025218	4.57	0.000	1.565325
smokww1	0	(no path)			0
age	-.059802	.0164137	-3.64	0.000	-.180148

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Table 5 Robust direct effects continued:

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
alcus~3 <-						
smokww0	0	(no path)				0
smokww2	0	(no path)				0
smokww3	.0087797	.0034586	2.54	0.011		.1193382
alcuseww0	0	(no path)				0
alcuseww1	0	(no path)				0
alcuseww2	.3977046	.1322344	3.01	0.003		.4542695
smokww1	0	(no path)				0
age	-.0370357	.0184954	-2.00	0.045		-.1274347
whpsl~p <-						
crhrw1	0	(no path)				0
crhrw2	8.854608	1.397842	6.33	0.000		.3285185
age	.3424499	.1134367	3.02	0.003		.1687002
whppa <-						
crhrw1	0	(no path)				0
whpsleep	.1312072	.0402968	3.26	0.001		.2238511
crhrw2	2.58612	.7967575	3.25	0.001		.163697
age	.2621885	.0657718	3.99	0.000		.2203605
cumdo~2 <-						
cumdose1	1.339597	.2873117	4.66	0.000		.8928449
cumdo~3 <-						
cumdose2	1.087217	.0775735	14.02	0.000		1.019854
cumdose1	-.0439337	.0846185	-0.52	0.604		-.0274676
crhrw2 <-						
crhrw1	1.140574	.1089308	10.47	0.000		1.15048
age	0	(no path)				0
crhrw3 <-						
crhrw1	-.1183935	.0379136	-3.12	0.002		-.1195333
crhrw2	1.055212	.0329604	32.01	0.000		1.056198
age	0	(no path)				0
smokww1 <-						
smokww0	.9937766	.0068764	144.52	0.000		.9825136
age	0	(no path)				0
smokww4 <-						
smokww0	0	(no path)				0
smokww2	-.7728833	.1605092	-4.82	0.000		-.7264674
smokww3	1.217832	.0508214	23.96	0.000		1.184419
alcuseww0	0	(no path)				0
alcuseww1	0	(no path)				0
alcuseww2	-.6730745	.3464082	-1.94	0.052		-.0550092
smokww1	.43886	.1233524	3.56	0.000		.4390801
age	0	(no path)				0

Continued on the next page...

Table 5 Robust direct effects continued:

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
alcus~4 <-						
smokww0	0	(no path)				0
smokww2	0	(no path)				0
smokww3	-.0154824	.0065657	-2.36	0.018		-.2049169
alcuseww0	0	(no path)				0
alcuseww1	0	(no path)				0
alcuseww2	-.1600712	.0598169	-2.68	0.007		-.1780356
alcuseww3	.9678354	.0651211	14.86	0.000		.9424145
smokww1	0	(no path)				0
smokww4	.0231128	.0071052	3.25	0.001		.3145386
age	0	(no path)				0
whpel <-						
crhrw1	0	(no path)				0
whpsleep	.3823403	.0643539	5.94	0.000		.3162568
whppa	.8244046	.1029768	8.01	0.000		.3996949
crhrw2	0	(no path)				0
age	0	(no path)				0

7.2 Indirect effects on male substance abuse

7.2.1 Hypothesis 20: Indirect effects from external dose mediated by Nottingham health scales

Two hypotheses pertain to indirect effects.To learn what happened with respect to indirect effects, we turn to the several panels of the alcohol and nicotine in Table 6. To test these hypotheses, we have to examine the five waves of nicotine and the five waves of alcoholic abuse in order to ascertain whether there are indirect effects stemming from the cumulative external dose for hypothesis 20 and from perceived risk of exposure for hypothesis 24. For hypothesis 20, we find no evidence in any of the smoking panels mention of cumulative external dose as a source of an indirect effect. Moreover, when we check the alcohol panels for each of the five waves, we find no mention of cumulative external dose either. If external radiation dose is not a source of an indirect effect on substance (by which we refer only to nicotine and alcohol in this matter), then mediation by the health scales is out of the question, as it were. Therefore, we find that hypothesis 20 is not consistent with our model of the data, which fits the data well.

7.2.2 Hypothesis 24: Indirect effects from perceived risk mediated by Nottingham health scales

When we examine the substance abuse panels in Table 6, we find no mention of the Chornobyl related health risk variables as sources of indirect effects on substance abuse. If the perceived risk of exposure is not source of an indirect effect of perceived risk, then mediation by the Nottingham health scales is not possible.

Merely because perceived risk does not indirectly impact substance abuse dose not mean that such perceived risk cannot impact any of the Nottingham health scales. As we can see in Figure 1, there is a path that extends from wave 2 Chornobyl related health risk to Nottingham sleep issues. From that point, one path extends to physical ability and another goes to energy level. It is clear that the Nottingham health measures are impacted both directly and indirectly by perceived risk. For a more comprehensive perspective, we have to turn to consideration the female model.

Table 6 Indirect effects among males

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

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
Structural					
crhrw1 <-					
age	0	(no path)			0
smokww0 <-					
age	0	(no path)			0
smokww2 <-					
smokww0	.9031127	.019075	47.35	0.000	.9504018
alcuseww0	.0250473	.5176138	0.05	0.961	.0023544
alcuseww1	2.508495	.5486071	4.57	0.000	.2468194
alcuseww2	0	(no path)			0
smokww1	.0541849	.0189066	2.87	0.004	.0576758
age	1.121028	.1745717	6.42	0.000	.29363
smokww3 <-					
smokww0	.6233348	.0131657	47.35	0.000	.6339736
smokww2	0	(no path)			0
alcuseww0	.0172878	.3572608	0.05	0.961	.0015705
alcuseww1	.6666545	.5899639	1.13	0.258	.0633945
alcuseww2	1.251654	.4322993	2.90	0.004	.1051813
smokww1	.6641049	.0210106	31.61	0.000	.6831824
age	.5750864	.1330817	4.32	0.000	.1455799
alcus~0 <-					
smokww0	0	(no path)			0
age	.038443	.0106611	3.61	0.000	.1071245
alcus~1 <-					
smokww0	.0831976	.0070324	11.83	0.000	.889836
alcuseww0	0	(no path)			0
smokww1	0	(no path)			0
age	.1486379	.018811	7.90	0.000	.3956829

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Table 6 male indirect effects continued:

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
alcus~2 <-					
smokww0	.0238064	.0270607	0.88	0.379	.2881309
alcuseww0	1.309767	.027517	47.60	0.000	1.415913
alcuseww1	0	(no path)			0
smokww1	.0776006	.027077	2.87	0.004	.9499718
age	.1699175	.0215548	7.88	0.000	.5118607
alcus~3 <-					
smokww0	.0149406	.010871	1.37	0.169	.2065464
smokww2	.0060598	.0004838	12.52	0.000	.0796056
smokww3	0	(no path)			0
alcuseww0	.3259767	.1147203	2.84	0.004	.402515
alcuseww1	.5559877	.1237191	4.49	0.000	.7186449
alcuseww2	.0109892	.0037955	2.90	0.004	.0125522
smokww1	.0366928	.0108745	3.37	0.001	.513073
age	.0401319	.0167694	2.39	0.017	.1380882
whpsl~p <-					
crhrw1	10.09934	.9645391	10.47	0.000	.3779541
crhrw2	0	(no path)			0
age	.248685	.0526473	4.72	0.000	.1225091
whppa <-					
crhrw1	4.274767	.4082625	10.47	0.000	.2729356
whpsleep	0	(no path)			0
crhrw2	1.161788	.1834068	6.33	0.000	.0735392
age	.1501933	.0318048	4.72	0.000	.1262324
cumdo~2 <-					
cumdose1	0	(no path)			0
cumdo~3 <-					
cumdose2	0	(no path)			0
cumdose1	1.456433	.2682484	5.43	0.000	.9105718
crhrw2 <-					
crhrw1	0	(no path)			0
age	.0280854	.0038108	7.37	0.000	.3729138
crhrw3 <-					
crhrw1	1.203548	.1149451	10.47	0.000	1.215135
crhrw2	0	(no path)			0
age	.0267207	.0037006	7.22	0.000	.3551257
smokww1 <-					
smokww0	0	(no path)			0
age	1.31792	.1889164	6.98	0.000	.3243077

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Table 6 male indirect effects continued:

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
smokww4 <-					
smokww0	.4812218	.0173813	27.69	0.000	.4760064
smokww2	.8405565	.0671138	12.52	0.000	.7900764
smokww3	0	(no path)			0
alcuseww0	-.5497304	.1538944	-3.57	0.000	-.0485696
alcuseww1	-.865683	.1720763	-5.03	0.000	-.0800621
alcuseww2	.1227217	.0423859	2.90	0.004	.0100298
smokww1	.0128829	.0171389	0.75	0.452	.0128894
age	-.6475952	.1904424	-3.40	0.001	-.1594372
alcus~4 <-					
smokww0	.012121	.0056041	2.16	0.031	.1631653
smokww2	-.003257	.003939	-0.83	0.408	-.0416626
smokww3	.0366449	.0035045	10.46	0.000	.4850114
alcuseww0	.1713778	.0570384	3.00	0.003	.2060585
alcuseww1	.2863523	.0615539	4.65	0.000	.3604046
alcuseww2	.3634495	.1242012	2.93	0.003	.4042383
alcuseww3	0	(no path)			0
smokww1	.02325	.0062023	3.75	0.000	.3165649
smokww4	0	(no path)			0
age	-.0231407	.0156311	-1.48	0.139	-.0775323
whpel <-					
crhrw1	7.385522	.7053557	10.47	0.000	.2286215
whpsleep	.1081678	.0332209	3.26	0.001	.0894721
whppa	0	(no path)			0
crhrw2	6.475267	.9958988	6.50	0.000	.1987183
age	.5659841	.0891675	6.35	0.000	.2306283

7.3 Total effects on male substance abuse

If there are neither direct nor indirect effects of cumulative external dose or perceived risk of exposure on substance abuse, there will be no total effects either. For the total effects are merely the sum of the direct and indirect effects. But what may be of interest are the changes in the path coefficients of the smoking and alcohol abuse as one goes from one wave to the next. The way we computed these effects, they constituted the average consumption of cigarettes per week for the extent of the wave. Wave 0 was 1985, wave 1 was 1986, wave 2 was the decade from 1987 through 1996. Wave 3 in this substance abuse analysis was the decade from 1997 through 2006, and wave 4 was the remaining time in the study before the interview.

Sometimes the change in the rates of smoking and alcohol abuse are of interest to those trying to analyze whether there was any impact due to the 1986 Chornobyl disaster. To facilitate such curiosity, we graph the changes in the rates from wave 1986 onward from the output of Table 3.

7.3.1 Segmented male smoking rates

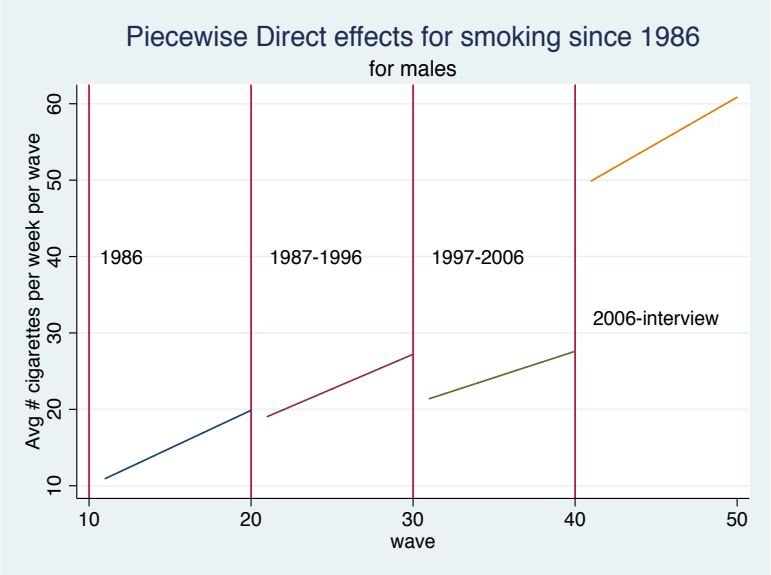

Figure 2: Piecewise rates of nicotine abuse among males per wave

From Figure 2, we can see that there was a slight increase in the amount of smoking in the decade after Chornobyl relative to that of 1986. But from 1997 to 2006, there seemed to be a drop in the rate of smoking increase. Notwithstanding, in the fourth wave shown in the graph, not only did the level of smoking increase, the rate of increase grew as well.

7.3.2 Segmented male alcohol consumption rates

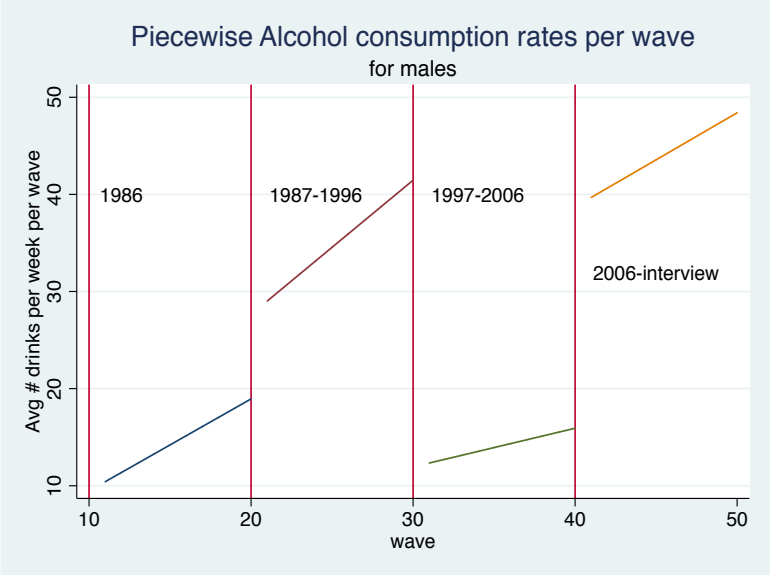

Figure 3: Piecewise rates of alcohol abuse among males per wave

From Figure 3, we can see also that the level and rate of alcohol consumption on the part of males increased greatly in the decade after Chornobyl only to drop in the 1997-2006 wave, only to rise again since 2006 to the time of the interview. In Table 7 below, we can observe the total effects on substance abuse for males. Because neither the direct nor indirect effects were significantly related to substance abuse for males, we will not elaborate on Table 7 at this time.

Table 7 Total clustered robust effects among males

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

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
Structural					
crhrw1 <-					
age	.0246239	.0038517	6.39	0.000	.3241375
smokww0 <-					
age	1.326173	.1899903	6.98	0.000	.3300796
smokww2 <-					
smokww0	.9031127	.019075	47.35	0.000	.9504018
alcuseww0	.0250473	.5176138	0.05	0.961	.0023544
alcuseww1	.965876	.8547635	1.13	0.258	.0950359
alcuseww2	1.813447	.6263327	2.90	0.004	.1576793
smokww1	.962182	.030441	31.61	0.000	1.024172
age	.8332084	.1755798	4.75	0.000	.2182416
smokww3 <-					
smokww0	.6233348	.0131657	47.35	0.000	.6339736
smokww2	.6902071	.0551092	12.52	0.000	.6670585
alcuseww0	.0172878	.3572608	0.05	0.961	.0015705
alcuseww1	.6666545	.5899639	1.13	0.258	.0633945
alcuseww2	1.251654	.4322993	2.90	0.004	.1051813
smokww1	.6641049	.0210106	31.61	0.000	.6831824
age	-.4170433	.1872345	-2.23	0.026	-.1055722
alcus~0 <-					
smokww0	.0289879	.0073173	3.96	0.000	.3245414
age	.1569215	.0191411	8.20	0.000	.437274
alcus~1 <-					
smokww0	.0274892	.0202732	1.36	0.175	.2940096
alcuseww0	.9468597	.0198926	47.60	0.000	.904549
smokww1	.0560992	.0195746	2.87	0.004	.6068846
age	.1784808	.0192445	9.27	0.000	.4751264
alcus~2 <-					
smokww0	.0238064	.0270607	0.88	0.379	.2881309
alcuseww0	.8192637	.2805817	2.92	0.004	.8856585
alcuseww1	1.383275	.3025218	4.57	0.000	1.565325
smokww1	.0776006	.027077	2.87	0.004	.9499718
age	.1101155	.0164911	6.68	0.000	.3317127

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Table 7 Total clustered robust effects among males continued:

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

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
alcus~3 <-					
smokww0	.0149406	.010871	1.37	0.169	.2065464
smokww2	.0060598	.0004838	12.52	0.000	.0796056
smokww3	.0087797	.0034586	2.54	0.011	.1193382
alcuseww0	.3259767	.1147203	2.84	0.004	.402515
alcuseww1	.5559877	.1237191	4.49	0.000	.7186449
alcuseww2	.4086938	.1323055	3.09	0.002	.4668216
smokww1	.0366928	.0108745	3.37	0.001	.513073
age	.0030962	.0162869	0.19	0.849	.0106534
whpsl~p <-					
crhrw1	10.09934	.9645391	10.47	0.000	.3779541
crhrw2	8.854608	1.397842	6.33	0.000	.3285185
age	.5911349	.1052043	5.62	0.000	.2912093
whppa <-					
crhrw1	4.274767	.4082625	10.47	0.000	.2729356
whpsleep	.1312072	.0402968	3.26	0.001	.2238511
crhrw2	3.747908	.8353091	4.49	0.000	.2372362
age	.4123818	.0643064	6.41	0.000	.3465929
cumdo~2 <-					
cumdose1	1.339597	.2873117	4.66	0.000	.8928449
cumdo~3 <-					
cumdose2	1.087217	.0775735	14.02	0.000	1.019854
cumdose1	1.412499	.3182587	4.44	0.000	.8831041
crhrw2 <-					
crhrw1	1.140574	.1089308	10.47	0.000	1.15048
age	.0280854	.0038108	7.37	0.000	.3729138
crhrw3 <-					
crhrw1	1.085154	.1185631	9.15	0.000	1.095602
crhrw2	1.055212	.0329604	32.01	0.000	1.056198
age	.0267207	.0037006	7.22	0.000	.3551257
smokww1 <-					
smokww0	.9937766	.0068764	144.52	0.000	.9825136
age	1.31792	.1889164	6.98	0.000	.3243077

Continued on the next page

Table 7 Total clustered robust effects among males continued:

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

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
smokww4 <-					
smokww0	.4812218	.0173813	27.69	0.000	.4760064
smokww2	.0676732	.1767633	0.38	0.702	.063609
smokww3	1.217832	.0508214	23.96	0.000	1.184419
alcuseww0	-.5497304	.1538944	-3.57	0.000	-.0485696
alcuseww1	-.865683	.1720763	-5.03	0.000	-.0800621
alcuseww2	-.5503527	.3474519	-1.58	0.113	-.0449794
smokww1	.4517429	.1253509	3.60	0.000	.4519695
age	-.6475952	.1904424	-3.40	0.001	-.1594372
alcus~4 <-					
smokww0	.012121	.0056041	2.16	0.031	.1631653
smokww2	-.003257	.003939	-0.83	0.408	-.0416626
smokww3	.0211624	.0071107	2.98	0.003	.2800946
alcuseww0	.1713778	.0570384	3.00	0.003	.2060585
alcuseww1	.2863523	.0615539	4.65	0.000	.3604046
alcuseww2	.2033782	.0939405	2.16	0.030	.2262027
alcuseww3	.9678354	.0651211	14.86	0.000	.9424145
smokww1	.02325	.0062023	3.75	0.000	.3165649
smokww4	.0231128	.0071052	3.25	0.001	.3145386
age	-.0231407	.0156311	-1.48	0.139	-.0775323
whpel <-					
crhrw1	7.385522	.7053557	10.47	0.000	.2286215
whpsleep	.4905081	.0689265	7.12	0.000	.4057289
whppa	.8244046	.1029768	8.01	0.000	.3996949
crhrw2	6.475267	.9958988	6.50	0.000	.1987183
age	.5659841	.0891675	6.35	0.000	.2306283

8 Pathways to Female substance abuse

Table 8: Alpha reliabilities of female Nottingham health scales

Gender	**Scale**
female	whpsleep = 0.746
female	whpel = 0.613
female	whppa = 0.789

In Figure 4, we present the path diagram for the female Chornobyl PTSD model. This diagram shows the statistically significant paths that extend to smoking and alcohol abuse among the females in our sample. To facilitate explanation the paths have been color-coded. Boxes represent variables and

arrows represent paths. The blue boxes with black borders in the middle are alcohol abuse with the ww and a number in the suffix indicating the wave of the study to which this box refers. The rose-colored boxes, represent the cumulative external dose reconstructed, with numeric suffixes representing the period of time to which they refer (for these variables case 1= 1986; 2= 1987-1996, inclusive; and 3 represents the time from 1997 to the time of the interview), have red arrows projecting from them. Chornobyl related health risk variables are represented by orange colored boxes, the w1, w2, and w3 suffix refers to the same time period as the cumulative dose variables do. Direct effects of the perceived risk of exposure variables have dark orange arrows projecting from them. The age variable is gold colored with magenta arrows emanating from it. boxes. The smoking and alcohol abuse variables have congruent time spans. The smoking abuse variables are stone colored and the alcohol abuse variables are light blue in color. The ww0 suffix refers to the average count per week in 1985. The ww1 suffix refers to the average count per week in 1986. The ww2 suffix is equal to the w2 suffix of the above mentioned waves. The ww3 suffix refers to the decade after that (from 1997 to 2006, inclusive). The ww4 suffix refers to the remaining time till the interview. Smoking abuse variables have sienna colored arrows and alcohol abuse variables have medium blue arrows stemming from them.

The Nottingham weighted health profile measures of physical health behavior include sleep and energy level, are colored grey, mint, and cyan, respectively. The path coefficients, which define this model, are contained in Table 9. The clustered-robust output follows in Table 10 and the clustered-robust versions for direct, indirect, and total effects, are respectively contained in Tables 11, 12, and 13.

8.1 Model goodness of fit

To help the reader interpret the path coefficients, Table 8 lists the parameter estimates from which the path diagram was developed. The non-robust version of the model is consistent with the data LR test of model vs. saturated: $\chi^2(142) = 161.43, Prob > \chi^2 = 0.1265$. All moduli reside within the unit circle, with the stability index = 0.00324, so the model satisfies the condition for stability.

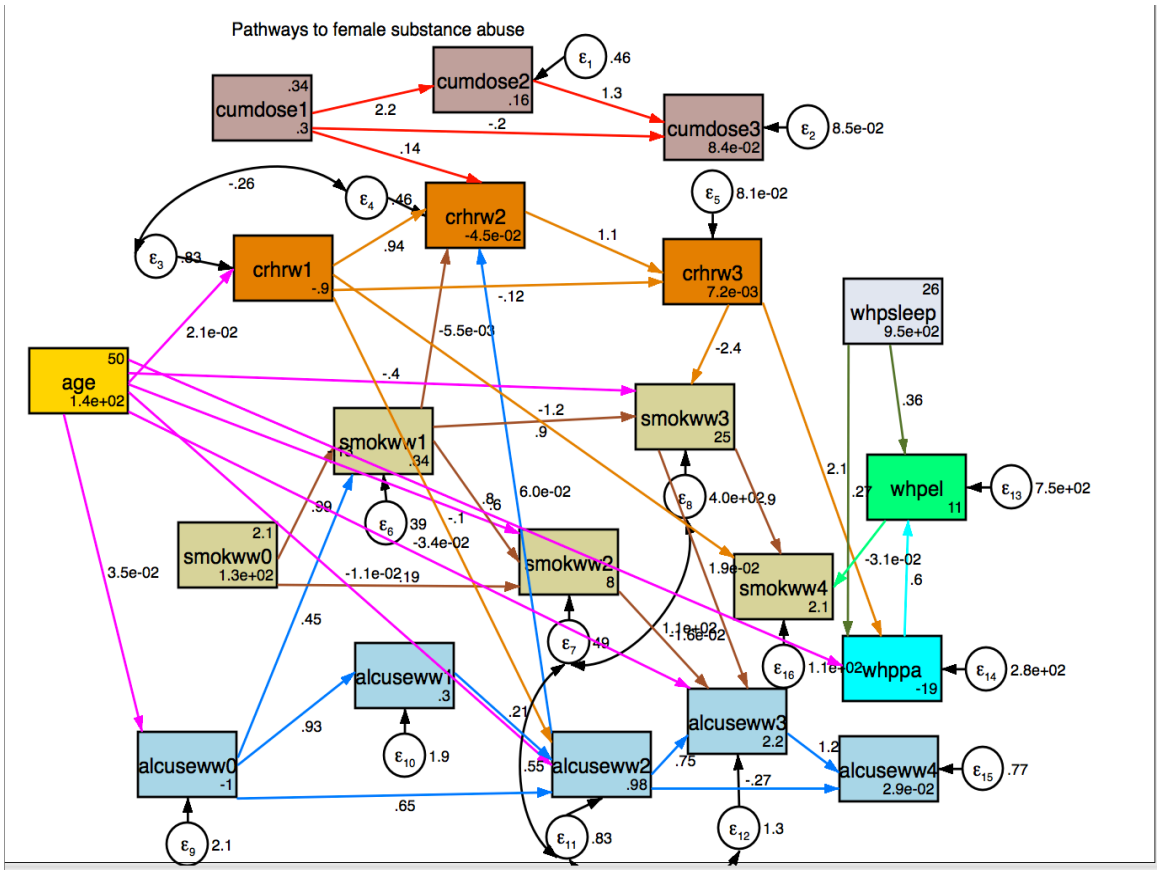

Figure 4: Pathways to female substance abuse

Table 9 Pathways to female substance abuse

```
 sembuilder H12H16femV3
(1 observations with missing values excluded;
 specify option ´method(mlmv)´ to use all observations)

Endogenous variables

Observed:  crhrw1 smokww2 smokww3 alcuseww0 alcuseww2 alcuseww3 whppa
           cumdose2 cumdose3 crhrw2 crhrw3 smokww4 smokww1 alcuseww1
           alcuseww4 whpel

Exogenous variables

Observed:  age cumdose1 smokww0 whpsleep

Structural equation model                       Number of obs      =       362
Estimation method  = ml
Log likelihood     = -17296.836
```

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
crhrw1 <-						
age	.0205051	.004054	5.06	0.000	.0125594	.0284508
_cons	-.8977192	.2093551	-4.29	0.000	-1.308048	-.4873908
smokww2 <-						
smokww1	.7999629	.0418515	19.11	0.000	.7179355	.8819903
age	-.1325128	.0312452	-4.24	0.000	-.1937523	-.0712734
smokww0	.1866472	.0401949	4.64	0.000	.1078666	.2654279
_cons	8.038197	1.611298	4.99	0.000	4.88011	11.19628
smokww3 <-						
crhrw3	-2.374025	.7351822	-3.23	0.001	-3.814955	-.9330942
smokww1	.9034685	.0798532	11.31	0.000	.7469591	1.059978
age	-.3964259	.0899408	-4.41	0.000	-.5727067	-.2201451
_cons	25.31099	4.614104	5.49	0.000	16.26751	34.35447
alcus~0 <-						
age	.0347107	.0064397	5.39	0.000	.0220891	.0473323
_cons	-1.046035	.3325573	-3.15	0.002	-1.697835	-.3942349
alcus~2 <-						
crhrw1	-.1012166	.0481806	-2.10	0.036	-.1956489	-.0067844
alcuseww0	.6470338	.0429171	15.08	0.000	.5629179	.7311497
alcuseww1	.2107588	.0320121	6.58	0.000	.1480161	.2735014
age	-.0113834	.0043518	-2.62	0.009	-.0199127	-.0028541
_cons	.9796737	.2167066	4.52	0.000	.5549365	1.404411

Continued on the next page...

Table 9 continued:

	OIM					
	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
alcus~3 <-						
smokww2	-.0159272	.0063506	-2.51	0.012	-.0283741	-.0034803
smokww3	.0189973	.003842	4.94	0.000	.0114671	.0265274
alcuseww2	.7525482	.0482082	15.61	0.000	.6580618	.8470345
age	-.0336993	.0052558	-6.41	0.000	-.0440004	-.0233982
_cons	2.204279	.2716675	8.11	0.000	1.67182	2.736738
whppa <-						
crhrw3	2.103182	1.038996	2.02	0.043	.0667873	4.139576
age	.6009001	.0815075	7.37	0.000	.4411483	.7606519
whpsleep	.2658971	.0311971	8.52	0.000	.2047519	.3270423
_cons	-19.04325	3.960639	-4.81	0.000	-26.80596	-11.28054
cumdo~2 <-						
cumdose1	2.188894	.0649526	33.70	0.000	2.061589	2.316199
_cons	.1613576	.0418234	3.86	0.000	.0793853	.2433299
cumdo~3 <-						
cumdose2	1.324089	.0225964	58.60	0.000	1.279801	1.368377
cumdose1	-.2032471	.0567996	-3.58	0.000	-.3145722	-.091922
_cons	.084056	.0183469	4.58	0.000	.0480968	.1200152
crhrw2 <-						
crhrw1	.9354104	.1500683	6.23	0.000	.641282	1.229539
alcuseww2	.0597861	.0213799	2.80	0.005	.0178823	.10169
smokww1	-.0055023	.0024847	-2.21	0.027	-.0103722	-.0006324
cumdose1	.1363607	.0599782	2.27	0.023	.0188057	.2539157
_cons	-.0452457	.0478137	-0.95	0.344	-.1389589	.0484675
crhrw3 <-						
crhrw1	-.1166559	.0216388	-5.39	0.000	-.1590671	-.0742447
crhrw2	1.051234	.0234364	44.85	0.000	1.005299	1.097168
_cons	.0072487	.0152171	0.48	0.634	-.0225762	.0370736
smokww4 <-						
crhrw1	-1.194947	.586065	-2.04	0.041	-2.343614	-.0462813
smokww3	.9034416	.0231699	38.99	0.000	.8580294	.9488538
whpel	-.0309623	.0160628	-1.93	0.054	-.0624448	.0005202
_cons	2.134998	.7747204	2.76	0.006	.6165739	3.653422

Continued on the next page...

Table 9 continued:

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
smokww1 <-						
alcuseww0	.446258	.2191344	2.04	0.042	.0167626	.8757535
smokww0	.9920893	.0285561	34.74	0.000	.9361203	1.048058
_cons	.3431263	.3641679	0.94	0.346	-.3706297	1.056882
alcus~1 <-						
alcuseww0	.929405	.0477703	19.46	0.000	.835777	1.023033
_cons	.2979573	.0792777	3.76	0.000	.1425758	.4533387
alcus~4 <-						
alcuseww2	-.2670228	.0435297	-6.13	0.000	-.3523395	-.1817061
alcuseww3	1.163152	.0365222	31.85	0.000	1.09157	1.234735
_cons	.0285771	.0579173	0.49	0.622	-.0849387	.1420928
whpel <-						
whppa	.5994792	.0793647	7.55	0.000	.4439273	.7550312
whpsleep	.3566229	.0549961	6.48	0.000	.2488325	.4644133
_cons	11.45168	2.009544	5.70	0.000	7.513043	15.39031
Variance						
e.crhrw1	.831243	.0617857			.718553	.961606
e.smokww2	49.2326	3.635216			42.59927	56.89884
e.smokww3	396.1007	29.44261			342.4008	458.2225
e.alcuse~0	2.097361	.1558956			1.813025	2.426289
e.alcuse~2	.8274865	.0612356			.7157649	.9566464
e.alcuse~3	1.299053	.1046608			1.109297	1.521267
e.whppa	276.4754	20.55026			238.9941	319.8349
e.cumdose2	.4605615	.0342333			.398124	.5327911
e.cumdose3	.0851282	.0063275			.0735875	.0984788
e.crhrw2	.4594331	.0858532			.3185372	.6626503
e.crhrw3	.0806603	.0059954			.0697253	.0933102
e.smokww4	109.3633	8.128907			94.53707	126.5146
e.smokww1	38.91189	2.892298			33.63668	45.01442
e.alcuse~1	1.871649	.1391186			1.617912	2.165178
e.alcuse~4	.7679058	.057078			.6638021	.888336
e.whpel	746.1812	55.46321			645.0227	863.2043
Covariance						
e.crhrw1						
e.crhrw2	-.2612985	.130159	-2.01	0.045	-.5164055	-.0061916
e.smokww2						
e.smokww3	111.4064	9.370356	11.89	0.000	93.04079	129.7719
e.alcuse~2	.5541184	.1943807	2.85	0.004	.1731392	.9350976
e.alcuse~2						
e.alcuse~3	.4156463	.0704492	5.90	0.000	.2775683	.5537243

LR test of model vs. saturated: chi2(142) = 161.43, Prob > chi2 = 0.1265

Stability analysis of simultaneous equation systems

Eigenvalue stability condition
stability index = .0032427
All the eigenvalues lie inside the unit circle.

Table 10 Clustered robust female substance abuse model

(1 observations with missing values excluded;

Endogenous variables

Observed: crhrw1 smokww2 smokww3 alcuseww0 alcuseww2 alcuseww3 whppa
cumdose2 cumdose3 crhrw2 crhrw3 smokww4 smokww1 alcuseww1
alcuseww4 whpel

Exogenous variables

Observed: age cumdose1 smokww0 whpsleep

Structural equation model Number of obs = 362
Estimation method = ml
Log pseudolikelihood= -17296.836

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Structural						
crhrw1 <-						
age	.0205051	.0039921	5.14	0.000	.0126808	.0283294
_cons	-.8977192	.2083333	-4.31	0.000	-1.306045	-.4893934
smokww2 <-						
smokww1	.7999629	.1529238	5.23	0.000	.5002378	1.099688
age	-.1325128	.0356171	-3.72	0.000	-.2023211	-.0627045
smokww0	.1866472	.137186	1.36	0.174	-.0822323	.4555268
_cons	8.038197	2.040918	3.94	0.000	4.03807	12.03832
smokww3 <-						
crhrw3	-2.374025	.9986543	-2.38	0.017	-4.331351	-.4166982
smokww1	.9034685	.0931679	9.70	0.000	.7208628	1.086074
age	-.3964259	.0873951	-4.54	0.000	-.5677171	-.2251347
_cons	25.31099	5.303879	4.77	0.000	14.91558	35.7064
alcus~0 <-						
age	.0347107	.005918	5.87	0.000	.0231116	.0463097
_cons	-1.046035	.2540945	-4.12	0.000	-1.544051	-.5480191
alcus~2 <-						
crhrw1	-.1012166	.0543892	-1.86	0.063	-.2078175	.0053843
alcuseww0	.6470338	.1438588	4.50	0.000	.3650757	.9289919
alcuseww1	.2107588	.1487288	1.42	0.156	-.0807443	.5022619
age	-.0113834	.0041419	-2.75	0.006	-.0195014	-.0032654
_cons	.9796737	.2134163	4.59	0.000	.5613855	1.397962

Continued on the next page...

Table 10 Clustered robust female model continued:

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
alcus~3 <-						
smokww2	-.0159272	.0077435	-2.06	0.040	-.0311043	-.0007501
smokww3	.0189973	.0066434	2.86	0.004	.0059765	.032018
alcuseww2	.7525482	.0475125	15.84	0.000	.6594253	.845671
age	-.0336993	.0057488	-5.86	0.000	-.0449667	-.0224319
_cons	2.204279	.3100079	7.11	0.000	1.596675	2.811883
whppa <-						
crhrw3	2.103182	.9897286	2.13	0.034	.1633492	4.043014
age	.6009001	.07503	8.01	0.000	.4538441	.7479561
whpsleep	.2658971	.0356483	7.46	0.000	.1960276	.3357666
_cons	-19.04325	3.43652	-5.54	0.000	-25.77871	-12.3078
cumdo~2 <-						
cumdose1	2.188894	.0836046	26.18	0.000	2.025032	2.352756
_cons	.1613576	.0418662	3.85	0.000	.0793013	.2434139
cumdo~3 <-						
cumdose2	1.324089	.1837822	7.20	0.000	.9638826	1.684295
cumdose1	-.2032471	.4120936	-0.49	0.622	-1.010936	.6044415
_cons	.084056	.0277894	3.02	0.002	.0295898	.1385223
crhrw2 <-						
crhrw1	.9354104	.1417718	6.60	0.000	.6575427	1.213278
alcuseww2	.0597861	.0221239	2.70	0.007	.0164241	.1031481
smokww1	-.0055023	.0030261	-1.82	0.069	-.0114334	.0004288
cumdose1	.1363607	.0514149	2.65	0.008	.0355893	.2371321
_cons	-.0452457	.0468409	-0.97	0.334	-.1370521	.0465607
crhrw3 <-						
crhrw1	-.1166559	.0316122	-3.69	0.000	-.1786147	-.054697
crhrw2	1.051234	.0277728	37.85	0.000	.9967999	1.105667
_cons	.0072487	.0158942	0.46	0.648	-.0239034	.0384008

Continued on the next page...

Table 10 Clustered robust female model continued:

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
smokww4 <-						
crhrw1	-1.194947	.5969269	-2.00	0.045	-2.364903	-.0249923
smokww3	.9034416	.0776154	11.64	0.000	.7513182	1.055565
whpel	-.0309623	.0134622	-2.30	0.021	-.0573477	-.0045769
_cons	2.134998	.7473273	2.86	0.004	.6702635	3.599733
smokww1 <-						
alcuseww0	.446258	.3997844	1.12	0.264	-.337305	1.229821
smokww0	.9920893	.0203878	48.66	0.000	.9521299	1.032049
_cons	.3431263	.3146583	1.09	0.276	-.2735926	.9598452
alcus~1 <-						
alcuseww0	.929405	.023482	39.58	0.000	.8833812	.9754288
_cons	.2979573	.0869724	3.43	0.001	.1274944	.4684201
alcus~4 <-						
alcuseww2	-.2670228	.0739495	-3.61	0.000	-.4119611	-.1220845
alcuseww3	1.163152	.1135474	10.24	0.000	.9406037	1.385701
_cons	.0285771	.0717265	0.40	0.690	-.1120043	.1691584

Continued on the next page...

Table 10 Clustered robust female model continued:

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
whpel <-						
whppa	.5994792	.0856918	7.00	0.000	.4315263	.7674322
whpsleep	.3566229	.05866	6.08	0.000	.2416513	.4715945
_cons	11.45168	1.826404	6.27	0.000	7.871991	15.03136
Variance						
e.crhrw1	.831243	.036922			.7619377	.9068522
e.smokww2	49.2326	14.29956			27.86263	86.99284
e.smokww3	396.1007	101.1362			240.1424	653.3447
e.alcuse~0	2.097361	.3559826			1.503834	2.92514
e.alcuse~2	.8274865	.1601589			.566255	1.209232
e.alcuse~3	1.299053	.2925047			.8355332	2.019714
e.whppa	276.4754	28.48551			225.9209	338.3425
e.cumdose2	.4605615	.2559619			.1549614	1.368837
e.cumdose3	.0851282	.0343901			.0385661	.1879065
e.crhrw2	.4594331	.0832405			.3221075	.6553053
e.crhrw3	.0806603	.0123716			.0597178	.1089472
e.smokww4	109.3633	34.595			58.8315	203.2979
e.smokww1	38.91189	20.04457			14.17769	106.7971
e.alcuse~1	1.871649	1.095957			.5940151	5.897272
e.alcuse~4	.7679058	.331554			.3294502	1.789889
e.whpel	746.1812	57.40898			641.7344	867.6273
Covariance						
e.crhrw1						
e.crhrw2	-.2612985	.1224971	-2.13	0.033	-.5013884	-.0212086
e.smokww2						
e.smokww3	111.4064	31.63578	3.52	0.000	49.40136	173.4113
e.alcuse~2	.5541184	.3629139	1.53	0.127	-.1571797	1.265417
e.alcuse~2						
e.alcuse~3	.4156463	.1260703	3.30	0.001	.1685531	.6627395

8.2 Does external dose directly effect female substance abuse?

8.2.1 A test of hypothesis 12

We examine the direct robust effects in Table 11 on pages 39 through 42 to test hypothesis 12 for females. Like the male model for substance abuse, where we find no evidence of a statistically significant clustered-robust direct effect originating with cumulative external dose and pointing to substance abuse, we observe no statistically significant direct effect stemming from cumulative external and extending to any of the smoking or alcohol panels in Table 11 either. We find no direct path from cumulative external dose in any wave to any of the substance abuse panels. Hence, we find no evidence in this model to support

hypothesis 12 among females, which postulates a direct relationship between cumulative external dose in mGys and substance abuse.

8.3 Does perceived risk of exposure directly effect female substance abuse?

8.3.1 A test of hypothesis 16

Hypothesis 16 posits a direct relationship between perceived Chornobyl health risk and substance abuse. To test this relationship, we examine the substance abuse panels on in Table 10 for women. In so doing, we find direct paths from perceived risk of exposure to smoking and alcohol abuse. Figure 4 reveals a direct path extending from 1986 perceived risk of exposure to alcohol abuse in the decade after the Chornobyl disaster that is almost yet not quite statistically significant. Moreover, it also reveals a direct path from 1986 perceived Chornobyl-related health risk path to smoking abuse in the more recent period of 1997 to the time of the interview. Although the sources appear to be somewhat intermittent, there is a repetition of this type of direct effect from perceived risk. Therefore, we do find partial confirmation of hypothesis 16 in these discoveries.

More specifically, we can turn to Table 11 for the parameter estimates for each of these effects, for we need to ascertain whether these are direct or inverse effects, albeit direct as opposed to indirect ones. Consider the two paths originating in 1986 perceived risk of exposure first. One of these direct effects extends to alcoholic consumption in wave (ww2) while the other extends to smoking abuse in wave (ww4). To locate the parameter estimate for the direct effect on alcoholic consumption in the second decade after Chornobyl, we turn to the alcus-2 panel on page 39, where we find that the parameter estimate ($crhrw1\ stdized\ \beta = -0.061,\ p = 0.063$), which is quasi-statistically significant, yet not quite statistically significant at the 0.05 level. Without additional evidence, we would not rely only on this indication for support. However, we do have two indications of perceived risk extending to smoking. From this same 1986 perceived risk, we find a direct path extending to the most smoking during recent period (2007 to the time of the interview) ($crhrw1\ stdized\ \beta = -0.047,\ p = 0.045$) under the smokww4 panel on page 41. But both of these indications are those of an inverse relationship. It may be possible that persons who smoke and drink are definitely dismissive of any perceived risk stemming from 1986. However, there is another relationship found between perceived risk in (1997 to the time of the interview) and smoking abuse in the ww3 period. On page 39 under the smokww3 panel, we find more evidence of a statistically significant inverse relationship ($crhrw3\ stdized\ \beta = -0.90,\ p = 0.017$). The finding of such a relationship suggests that these individuals dismiss the notion of a perceived risk as it relates to smoking. To the extent that these direct effects explain substance abuse, we have partial confirmation or support of hypothesis 16.

Table 11 Clustered robust direct effects of female substance abuse model

Direct effects

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
Structural					
crhrw1 <-					
age	.0205051	.0039921	5.14	0.000	.2569132
smokww2 <-					
alcuseww0	0	(no path)			0
smokww1	.7999629	.1529238	5.23	0.000	.7341934
age	-.1325128	.0356171	-3.72	0.000	-.1099598
smokww0	.1866472	.137186	1.36	0.174	.151354
smokww3 <-					
crhrw1	0	(no path)			0
alcuseww0	0	(no path)			0
alcuseww2	0	(no path)			0
crhrw2	0	(no path)			0
crhrw3	-2.374025	.9986543	-2.38	0.017	-.0897303
smokww1	.9034685	.0931679	9.70	0.000	.4974355
alcuseww1	0	(no path)			0
age	-.3964259	.0873951	-4.54	0.000	-.1973428
cumdose1	0	(no path)			0
smokww0	0	(no path)			0
alcus~0 <-					
age	.0347107	.005918	5.87	0.000	.2725702
alcus~2 <-					
crhrw1	-.1012166	.0543892	-1.86	0.063	-.0610767
alcuseww0	.6470338	.1438588	4.50	0.000	.6229583
alcuseww1	.2107588	.1487288	1.42	0.156	.2637821
age	-.0113834	.0041419	-2.75	0.006	-.0860637
alcus~3 <-					
crhrw1	0	(no path)			0
smokww2	-.0159272	.0077435	-2.06	0.040	-.1217569
smokww3	.0189973	.0066434	2.86	0.004	.2420817
alcuseww0	0	(no path)			0
alcuseww2	.7525482	.0475125	15.84	0.000	.6314183
crhrw2	0	(no path)			0
crhrw3	0	(no path)			0
smokww1	0	(no path)			0
alcuseww1	0	(no path)			0
age	-.0336993	.0057488	-5.86	0.000	-.2137722
cumdose1	0	(no path)			0
smokww0	0	(no path)			0

Continued on the next page ...

Table 11 Clustered robust direct effects of female substance abuse model continued:

Direct effects

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
whppa <-					
crhrw1	0	(no path)			0
alcuseww0	0	(no path)			0
alcuseww2	0	(no path)			0
crhrw2	0	(no path)			0
crhrw3	2.103182	.9897286	2.13	0.034	.0886955
smokww1	0	(no path)			0
alcuseww1	0	(no path)			0
age	.6009001	.07503	8.01	0.000	.3337586
cumdose1	0	(no path)			0
smokww0	0	(no path)			0
whpsleep	.2658971	.0356483	7.46	0.000	.3860204
cumdo~2 <-					
cumdose1	2.188894	.0836046	26.18	0.000	.8708001
cumdo~3 <-					
cumdose2	1.324089	.1837822	7.20	0.000	1.040956
cumdose1	-.2032471	.4120936	-0.49	0.622	-.0635672
crhrw2 <-					
crhrw1	.9354104	.1417718	6.60	0.000	1.004591
alcuseww0	0	(no path)			0
alcuseww2	.0597861	.0221239	2.70	0.007	.1064055
smokww1	-.0055023	.0030261	-1.82	0.069	-.0818875
alcuseww1	0	(no path)			0
age	0	(no path)			0
cumdose1	.1363607	.0514149	2.65	0.008	.0852467
smokww0	0	(no path)			0
crhrw3 <-					
crhrw1	-.1166559	.0316122	-3.69	0.000	-.1226275
alcuseww0	0	(no path)			0
alcuseww2	0	(no path)			0
crhrw2	1.051234	.0277728	37.85	0.000	1.028948
smokww1	0	(no path)			0
alcuseww1	0	(no path)			0
age	0	(no path)			0
cumdose1	0	(no path)			0
smokww0	0	(no path)			0

Continued on the next page ...

Table 11 Clustered robust direct effects of female substance abuse model continued:

Direct effects

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
smokww4 <-					
crhrw1	-1.194947	.5969269	-2.00	0.045	-.046828
smokww3	.9034416	.0776154	11.64	0.000	.8910907
alcuseww0	0	(no path)			0
alcuseww2	0	(no path)			0
whppa	0	(no path)			0
crhrw2	0	(no path)			0
crhrw3	0	(no path)			0
smokww1	0	(no path)			0
alcuseww1	0	(no path)			0
whpel	-.0309623	.0134622	-2.30	0.021	-.044133
age	0	(no path)			0
cumdose1	0	(no path)			0
smokww0	0	(no path)			0
whpsleep	0	(no path)			0
smokww1 <-					
alcuseww0	.446258	.3997844	1.12	0.264	.0513814
age	0	(no path)			0
smokww0	.9920893	.0203878	48.66	0.000	.8765618
alcus~1 <-					
alcuseww0	.929405	.023482	39.58	0.000	.7149529
age	0	(no path)			0
alcus~4 <-					
crhrw1	0	(no path)			0
smokww2	0	(no path)			0
smokww3	0	(no path)			0
alcuseww0	0	(no path)			0
alcuseww2	-.2670228	.0739495	-3.61	0.000	-.2013299
alcuseww3	1.163152	.1135474	10.24	0.000	1.045234
crhrw2	0	(no path)			0
crhrw3	0	(no path)			0
smokww1	0	(no path)			0
alcuseww1	0	(no path)			0
age	0	(no path)			0
cumdose1	0	(no path)			0
smokww0	0	(no path)			0

Continued on the next page ...

Table 11 Clustered robust direct effects of female substance abuse model continued:

Direct effects

(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
whpel <-					
crhrw1	0	(no path)			0
alcuseww0	0	(no path)			0
alcuseww2	0	(no path)			0
whppa	.5994792	.0856918	7.00	0.000	.3717876
crhrw2	0	(no path)			0
crhrw3	0	(no path)			0
smokww1	0	(no path)			0
alcuseww1	0	(no path)			0
age	0	(no path)			0
cumdose1	0	(no path)			0
smokww0	0	(no path)			0
whpsleep	.3566229	.05866	6.08	0.000	.3210899

8.4 Indirect effects on female substance abuse

8.4.1 Hypothesis 20 Do the health measures mediate the female dose-substance abuse relationship?

Hypothesis 20 relates to indirect effects of radiation dose on female substance abuse. An examination of Figure 4 reveals that there is a path that extends from cumulative external dose in 1986 to perceived risk in the decade thereafter, which then leads to later perceived risk (crhrw3) and from there to Nottingham physical ability and from there to Nottingham measure of energy level and from there to smoking in the most recent wave (ww4). This circuitous indirect connection could partially support hypothesis 20 of an indirect path, mediated by a Nottingham health measure, of recent substance abuse in the form of smoking.

To find evidence of this, we turn to Table 12, page 45, to examine the smokww4 panel to determine whether after such a circuitous route the effects stemming from cumulative external dose in 1986 are still statistically significant. However, we find that the effect is only of quasi-statistical significance after such a journey ($cumdose1\ stdized\ \beta = -0.021,\ p = 0.084$). Although this is not quite statistically significant at the 0.05 level, it is not sufficiently statistically significant for us to maintain that there is a relationship without more confirming evidence. However, when we examine the other substance abuse panels in Table 12, we find no evidence of a statistically significant cumulative external dose indirect effect. Hence, we have to admit that we lack confirming evidence of hypothesis 20 from our data.

8.4.2 Hypothesis 24: Do Nottingham health measures mediate a perceived risk impact on substance abuse?

Hypothesis 24 relates to perceived risk of radiation exposure explaining or predicting substance abuse while being mediated by Nottingham health measures. We will examine the indirect paths first under the smokww4. All three waves of perceived Chornobyl health related risk have significant indirect paths to smoking in this most recent wave (ww4). We turn to Table 12, page 45, to find the evidence for such a crhrw3 indirect path. Under the smokww4 panel, we observe that both paths from crhrw3 and crhrw1 are statistically significant indirect paths. ($crhrw3$ $stdized$ $\beta = -0.081,\ p = 0.016$)., ($crhrw2$ $stdized\beta = -0.084,\ p = 0.000$) and ($crhrw1$ $stdized$ $\beta = -0.074,\ p = 0.000$).. The significant inverse relationships on the part of smokers suggests a definite denial of the perceived risk of exposure. Although this may appear unreasonable, it may not be if most the sample lived and worked sufficiently far from the accident site. In the same panel, there is also evidence of a significant indirect effect of Nottingham physical ability $whppa$ $stdized$ $\beta = -0.016,\ p = 0.000$). Because there is no direct effect of whppa on smokww4 (Table 11, p.40), the effect must travel from crhrw3 to whppa and then to whpel and then to smokww4, which confirms a mediation by Nottingham health scale measure. To the extent that this observation is supported by the data, we have confirmation of hypothesis 24.

Table 12 Clustered robust Indirect effects on female substance abuse
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
Structural					
crhrw1 <-					
age	0	(no path)			0
smokww2 <-					
alcuseww0	.3569899	.3198127	1.12	0.264	.0377239
smokww1	0	(no path)			0
age	.0123914	.010708	1.16	0.247	.0102824
smokww0	.7936346	.1522557	5.21	0.000	.6435659
smokww3 <-					
crhrw1	-2.042415	.362105	-5.64	0.000	-.0811483
alcuseww0	.2835405	.3695709	0.77	0.443	.0179746
alcuseww2	-.1492055	.0552135	-2.70	0.007	-.0098242
crhrw2	-2.495655	.0659333	-37.85	0.000	-.0923279
crhrw3	0	(no path)			0
smokww1	.0137318	.0075522	1.82	0.069	.0075605
alcuseww1	-.0314464	.0221912	-1.42	0.156	-.0025914
age	-.0303396	.0248875	-1.22	0.223	-.0151032
cumdose1	-.3403092	.1915319	-1.78	0.076	-.0078706
smokww0	.9099445	.0913766	9.96	0.000	.4426603
alcus~0 <-					
age	0	(no path)			0
alcus~2 <-					
crhrw1	0	(no path)			0
alcuseww0	.1958803	.004949	39.58	0.000	.1885918
alcuseww1	0	(no path)			0
age	.0271826	.0053033	5.13	0.000	.205513
alcus~3 <-					
crhrw1	-.1149707	.0404647	-2.84	0.004	-.0582094
smokww2	0	(no path)			0
smokww3	0	(no path)			0
alcuseww0	.634034	.1059936	5.98	0.000	.5121857
alcuseww2	-.0028345	.0010489	-2.70	0.007	-.0023783
crhrw2	-.0474106	.0012526	-37.85	0.000	-.0223509
crhrw3	-.0451	.0189717	-2.38	0.017	-.0217221
smokww1	.0046831	.0016302	2.87	0.004	.0328572
alcuseww1	.1580087	.111504	1.42	0.156	.1659295
age	.0056955	.0050037	1.14	0.255	.0361296
cumdose1	-.0064649	.0050238	-1.29	0.198	-.0019053
smokww0	.0016733	.0030017	0.56	0.577	.010373

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Table 12 Clustered robust Indirect effects on female substance abuse
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
whppa <-					
crhrw1	1.809404	.3207939	5.64	0.000	.0802124
alcuseww0	.1059903	.019846	5.34	0.000	.0074969
alcuseww2	.1321833	.0489144	2.70	0.007	.0097109
crhrw2	2.210935	.0584113	37.85	0.000	.0912631
crhrw3	0	(no path)			0
smokww1	-.0121652	.0066906	-1.82	0.069	-.0074733
alcuseww1	.0278588	.0196595	1.42	0.156	.0025616
age	.0392763	.0205138	1.91	0.056	.0218153
cumdose1	.3014847	.17649	1.71	0.088	.0077799
smokww0	-.0120689	.0090575	-1.33	0.183	-.0065508
whpsleep	0	(no path)			0
cumdo~2 <-					
cumdose1	0	(no path)			0
cumdo~3 <-					
cumdose2	0	(no path)			0
cumdose1	2.89829	.4222766	6.86	0.000	.9064647
crhrw2 <-					
crhrw1	-.0060514	.0032517	-1.86	0.063	-.0064989
alcuseww0	.0479391	.0089763	5.34	0.000	.0821459
alcuseww2	0	(no path)			0
smokww1	0	(no path)			0
alcuseww1	.0126005	.0088919	1.42	0.156	.0280679
age	.02004	.0036636	5.47	0.000	.2696558
cumdose1	0	(no path)			0
smokww0	-.0054587	.0030497	-1.79	0.073	-.0717795
crhrw3 <-					
crhrw1	.9769734	.149504	6.53	0.000	1.026985
alcuseww0	.0503952	.0094362	5.34	0.000	.0845238
alcuseww2	.0628492	.0232574	2.70	0.007	.1094857
crhrw2	0	(no path)			0
smokww1	-.0057842	.0031812	-1.82	0.069	-.084258
alcuseww1	.013246	.0093475	1.42	0.156	.0288804
age	.0186747	.0035673	5.23	0.000	.2459572
cumdose1	.143347	.0539042	2.66	0.008	.0877144
smokww0	-.0057384	.0032007	-1.79	0.073	-.0738574

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Table 12 Clustered robust Indirect effects on female substance abuse
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
smokww4 <-					
crhrw1	-1.878788	.3330951	-5.64	0.000	-.0736266
smokww3	0	(no path)			0
alcuseww0	.254195	.3340332	0.76	0.447	.015894
alcuseww2	-.137252	.0507901	-2.70	0.007	-.0089136
whppa	-.0185613	.0026532	-7.00	0.000	-.0164081
crhrw2	-2.295716	.0606511	-37.85	0.000	-.08377
crhrw3	-2.18383	.9032152	-2.42	0.016	-.0814132
smokww1	.8288626	.0821641	10.09	0.000	.4501199
alcuseww1	-.0289271	.0204133	-1.42	0.156	-.0023512
whpel	0	(no path)			0
age	-.4219427	.0875753	-4.82	0.000	-.2071737
cumdose1	-.3130455	.1811285	-1.73	0.084	-.0071411
smokww0	.8223057	.1149107	7.16	0.000	.3945579
whpsleep	-.0159772	.0069942	-2.28	0.022	-.0205045
smokww1 <-					
alcuseww0	0	(no path)			0
age	.0154899	.0147035	1.05	0.292	.014005
smokww0	0	(no path)			0
alcus~1 <-					
alcuseww0	0	(no path)			0
age	.0322603	.0056695	5.69	0.000	.1948749
alcus~4 <-					
crhrw1	-.1067013	.0328408	-3.25	0.001	-.048546
smokww2	-.0185258	.0090069	-2.06	0.040	-.1272645
smokww3	.0220967	.0077273	2.86	0.004	.2530322
alcuseww0	.512401	.0854773	5.99	0.000	.3719649
alcuseww2	.8720313	.0554578	15.72	0.000	.6574943
alcuseww3	0	(no path)			0
crhrw2	-.0551458	.0014569	-37.85	0.000	-.0233619
crhrw3	-.0524581	.022067	-2.38	0.017	-.0227047
smokww1	.0054472	.0018962	2.87	0.004	.0343435
alcuseww1	.1275109	.0899822	1.42	0.156	.120328
age	-.0367914	.0092785	-3.97	0.000	-.2097269
cumdose1	-.0075197	.0058417	-1.29	0.198	-.0019915
smokww0	.0019463	.0034755	0.56	0.575	.0108422

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Table 12 Clustered robust Indirect effects on female substance abuse
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
whpel <-					
crhrw1	1.0847	.1923093	5.64	0.000	.029822
alcuseww0	.063539	.0118973	5.34	0.000	.0027872
alcuseww2	.0792411	.0293232	2.70	0.007	.0036104
whppa	0	(no path)			0
crhrw2	1.32541	.0350163	37.85	0.000	.0339305
crhrw3	1.260814	.5933218	2.13	0.034	.0329759
smokww1	-.0072928	.0040109	-1.82	0.069	-.0027785
alcuseww1	.0167008	.0117854	1.42	0.156	.0009524
age	.3837725	.0728568	5.27	0.000	.132198
cumdose1	.1807338	.1110392	1.63	0.104	.0028925
smokww0	-.0072351	.0055826	-1.30	0.195	-.0024355
whpsleep	.1593998	.0294656	5.41	0.000	.1435176

8.5 Longitudinal patterns of substance abuse among females

Because we have tested hypotheses 12, 16, 20, and 24, we need not belabor those findings. However, the question arises as to whether there is any impact of the Chornobyl disaster on the patterns ob substance abuse over time. To ascertain the answer to this question, it helps to examine the trends as represented by a piecewise conjunction of regression slopes describing these activities over the several waves included in our study. From the output of our models, we can construct peicewise regression models depicting the approximate trends for substance abuse on the part of women and men during these periods. From Figure 5, we can see that the trends for smoking have persisted over time, with the exception of a slight drop in the decade after Chornobyl.

But the alcoholic consumption trends have been more variable. They appear to have slacked off in the decade following Chornobyl but after that almost resumed their 1986 pattern until recent years when the trend seems to have increased even more than before both in level and slope.

A more elaborate exploration of these trends will have to await completion of testing the other hypotheses.

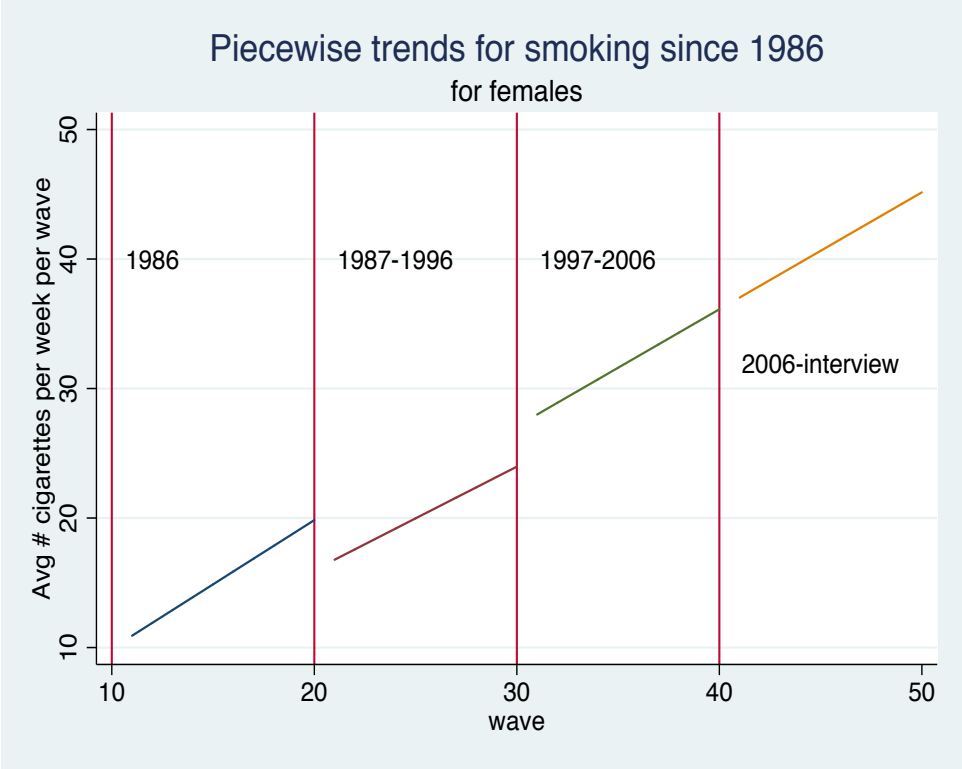

Figure 5: Pathways to female nicotine abuse

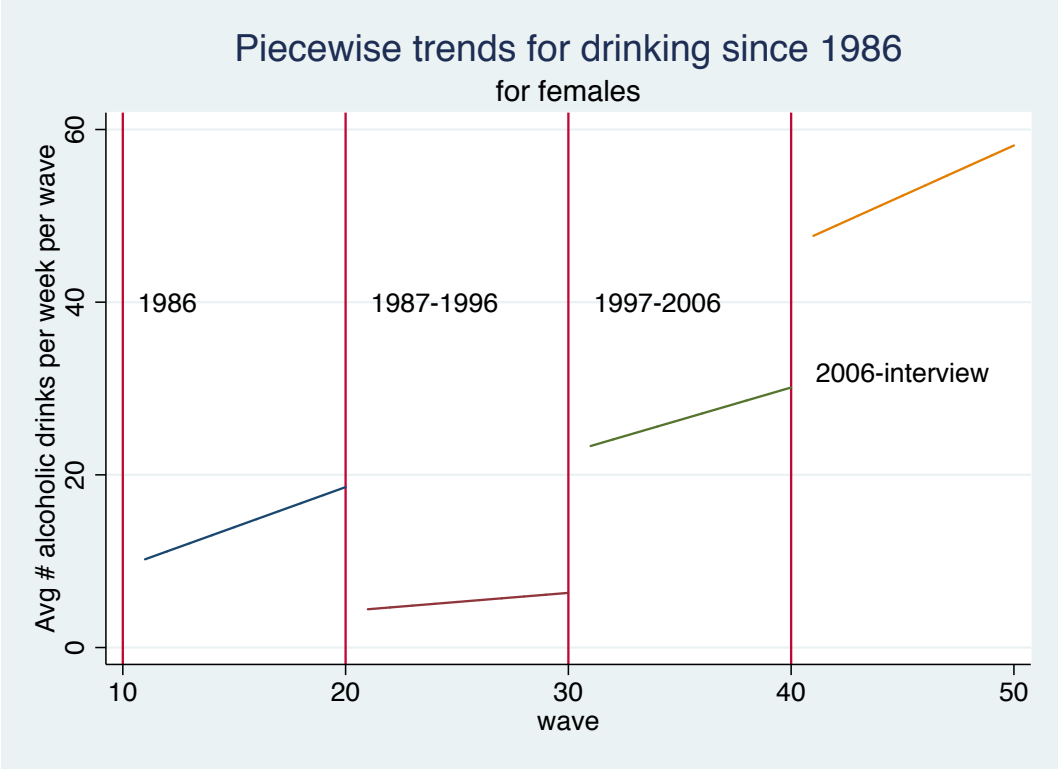

Figure 6: Pathways to female alcoholic consumption

Table 13 Clustered robust Total effects on female substance abuse
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
Structural					
crhrw1 <-					
age	.0205051	.0039921	5.14	0.000	.2569132
smokww2 <-					
alcuseww0	.3569899	.3198127	1.12	0.264	.0377239
smokww1	.7999629	.1529238	5.23	0.000	.7341934
age	-.1201215	.0336923	-3.57	0.000	-.0996774
smokww0	.9802818	.030351	32.30	0.000	.79492
smokww3 <-					
crhrw1	-2.042415	.362105	-5.64	0.000	-.0811483
alcuseww0	.2835405	.3695709	0.77	0.443	.0179746
alcuseww2	-.1492055	.0552135	-2.70	0.007	-.0098242
crhrw2	-2.495655	.0659333	-37.85	0.000	-.0923279
crhrw3	-2.374025	.9986543	-2.38	0.017	-.0897303
smokww1	.9172002	.0909802	10.08	0.000	.504996
alcuseww1	-.0314464	.0221912	-1.42	0.156	-.0025914
age	-.4267655	.0924742	-4.61	0.000	-.212446
cumdose1	-.3403092	.1915319	-1.78	0.076	-.0078706
smokww0	.9099445	.0913766	9.96	0.000	.4426603
alcus~0 <-					
age	.0347107	.005918	5.87	0.000	.2725702
alcus~2 <-					
crhrw1	-.1012166	.0543892	-1.86	0.063	-.0610767
alcuseww0	.842914	.1416277	5.95	0.000	.8115501
alcuseww1	.2107588	.1487288	1.42	0.156	.2637821
age	.0157992	.0058668	2.69	0.007	.1194494
alcus~3 <-					
crhrw1	-.1149707	.0404647	-2.84	0.004	-.0582094
smokww2	-.0159272	.0077435	-2.06	0.040	-.1217569
smokww3	.0189973	.0066434	2.86	0.004	.2420817
alcuseww0	.634034	.1059936	5.98	0.000	.5121857
alcuseww2	.7497137	.0476789	15.72	0.000	.62904
crhrw2	-.0474106	.0012526	-37.85	0.000	-.0223509
crhrw3	-.0451	.0189717	-2.38	0.017	-.0217221
smokww1	.0046831	.0016302	2.87	0.004	.0328572
alcuseww1	.1580087	.111504	1.42	0.156	.1659295
age	-.0280038	.0075753	-3.70	0.000	-.1776426
cumdose1	-.0064649	.0050238	-1.29	0.198	-.0019053
smokww0	.0016733	.0030017	0.56	0.577	.010373

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Table 13 Clustered robust total effects on female substance abuse continued
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
whppa <-					
crhrw1	1.809404	.3207939	5.64	0.000	.0802124
alcuseww0	.1059903	.019846	5.34	0.000	.0074969
alcuseww2	.1321833	.0489144	2.70	0.007	.0097109
crhrw2	2.210935	.0584113	37.85	0.000	.0912631
crhrw3	2.103182	.9897286	2.13	0.034	.0886955
smokww1	-.0121652	.0066906	-1.82	0.069	-.0074733
alcuseww1	.0278588	.0196595	1.42	0.156	.0025616
age	.6401764	.0745113	8.59	0.000	.3555739
cumdose1	.3014847	.17649	1.71	0.088	.0077799
smokww0	-.0120689	.0090575	-1.33	0.183	-.0065508
whpsleep	.2658971	.0356483	7.46	0.000	.3860204
cumdo~2 <-					
cumdose1	2.188894	.0836046	26.18	0.000	.8708001
cumdo~3 <-					
cumdose2	1.324089	.1837822	7.20	0.000	1.040956
cumdose1	2.695043	.1392837	19.35	0.000	.8428975
crhrw2 <-					
crhrw1	.929359	.1422177	6.53	0.000	.9980918
alcuseww0	.0479391	.0089763	5.34	0.000	.0821459
alcuseww2	.0597861	.0221239	2.70	0.007	.1064055
smokww1	-.0055023	.0030261	-1.82	0.069	-.0818875
alcuseww1	.0126005	.0088919	1.42	0.156	.0280679
age	.02004	.0036636	5.47	0.000	.2696558
cumdose1	.1363607	.0514149	2.65	0.008	.0852467
smokww0	-.0054587	.0030497	-1.79	0.073	-.0717795
crhrw3 <-					
crhrw1	.8603176	.1525279	5.64	0.000	.9043572
alcuseww0	.0503952	.0094362	5.34	0.000	.0845238
alcuseww2	.0628492	.0232574	2.70	0.007	.1094857
crhrw2	1.051234	.0277728	37.85	0.000	1.028948
smokww1	-.0057842	.0031812	-1.82	0.069	-.084258
alcuseww1	.013246	.0093475	1.42	0.156	.0288804
age	.0186747	.0035673	5.23	0.000	.2459572
cumdose1	.143347	.0539042	2.66	0.008	.0877144
smokww0	-.0057384	.0032007	-1.79	0.073	-.0738574

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Table 13 Clustered robust total effects on female substance abuse continued
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
smokww4 <-					
crhrw1	-3.073735	.7286851	-4.22	0.000	-.1204546
smokww3	.9034416	.0776154	11.64	0.000	.8910907
alcuseww0	.254195	.3340332	0.76	0.447	.015894
alcuseww2	-.137252	.0507901	-2.70	0.007	-.0089136
whppa	-.0185613	.0026532	-7.00	0.000	-.0164081
crhrw2	-2.295716	.0606511	-37.85	0.000	-.08377
crhrw3	-2.18383	.9032152	-2.42	0.016	-.0814132
smokww1	.8288626	.0821641	10.09	0.000	.4501199
alcuseww1	-.0289271	.0204133	-1.42	0.156	-.0023512
whpel	-.0309623	.0134622	-2.30	0.021	-.044133
age	-.4219427	.0875753	-4.82	0.000	-.2071737
cumdose1	-.3130455	.1811285	-1.73	0.084	-.0071411
smokww0	.8223057	.1149107	7.16	0.000	.3945579
whpsleep	-.0159772	.0069942	-2.28	0.022	-.0205045
smokww1 <-					
alcuseww0	.446258	.3997844	1.12	0.264	.0513814
age	.0154899	.0147035	1.05	0.292	.014005
smokww0	.9920893	.0203878	48.66	0.000	.8765618
alcus~1 <-					
alcuseww0	.929405	.023482	39.58	0.000	.7149529
age	.0322603	.0056695	5.69	0.000	.1948749
alcus~4 <-					
crhrw1	-.1067013	.0328408	-3.25	0.001	-.048546
smokww2	-.0185258	.0090069	-2.06	0.040	-.1272645
smokww3	.0220967	.0077273	2.86	0.004	.2530322
alcuseww0	.512401	.0854773	5.99	0.000	.3719649
alcuseww2	.6050085	.0956995	6.32	0.000	.4561644
alcuseww3	1.163152	.1135474	10.24	0.000	1.045234
crhrw2	-.0551458	.0014569	-37.85	0.000	-.0233619
crhrw3	-.0524581	.022067	-2.38	0.017	-.0227047
smokww1	.0054472	.0018962	2.87	0.004	.0343435
alcuseww1	.1275109	.0899822	1.42	0.156	.120328
age	-.0367914	.0092785	-3.97	0.000	-.2097269
cumdose1	-.0075197	.0058417	-1.29	0.198	-.0019915
smokww0	.0019463	.0034755	0.56	0.575	.0108422

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Table 13 Clustered robust total effects on female substance abuse continued
(Std. Err. adjusted for 362 clusters in id)

	Coef.	Robust Std. Err.	z	P>|z|	Std. Coef.
whpel <-					
crhrw1	1.0847	.1923093	5.64	0.000	.029822
alcuseww0	.063539	.0118973	5.34	0.000	.0027872
alcuseww2	.0792411	.0293232	2.70	0.007	.0036104
whppa	.5994792	.0856918	7.00	0.000	.3717876
crhrw2	1.32541	.0350163	37.85	0.000	.0339305
crhrw3	1.260814	.5933218	2.13	0.034	.0329759
smokww1	-.0072928	.0040109	-1.82	0.069	-.0027785
alcuseww1	.0167008	.0117854	1.42	0.156	.0009524
age	.3837725	.0728568	5.27	0.000	.132198
cumdose1	.1807338	.1110392	1.63	0.104	.0028925
smokww0	-.0072351	.0055826	-1.30	0.195	-.0024355
whpsleep	.5160227	.051113	10.10	0.000	.4646074

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