

## **Social relationships & partnership**

Soc-B Module 1: The Biosocial Life Course 2-5 Oct 2023



## Outline

- Key dimensions social relationships
- Social relationships over the life course and in relation to ageing
- Associations between social relationships & mortality, health – biomarkers as mediators?
- Evidence of links with biomarkers
  - HPA axis response
  - Inflammation
  - Blood pressure
  - Adiposity
- Gender differences



## **Key characteristics of social relationships**

Conceptualised & studied at the both the area/collective level and at the individual level

- Structural aspects
- Functional aspects
- Partnership / marriage as a special case
- Social capital



## **Social Capital**

Sometime used to refer broadly to the entire set of resources derived socially either at the group/area or individual level (alongside other forms of capital, eg. economic, cultural).

"Resources that are accessed by individuals as a result of their membership of a network or group."

- Kawachi & Berkman 2015

Tends to be studied at area level -- area based social attributes, rather than individual social relationships.

Also has structural and functional aspects



## **Social Capital**

OECD definition (2001): **Networks** with shared norms, values and understanding that **facilitate co-operation** within and among groups.

Putman (2000): Social capital as a public good – If you are in an area with high social capital, you can benefit from the resources/functional aspects without individually being part of the network.

Bonding v Bridging capital

- Bonding: Resources shared within networks/groups that are 'homophilous'. (The dark side of social capital?)
- Bridging: Resources shared across networks.



## High levels of collective efficacy linked with positive area/neighbourhood outcomes

### Social cohesion $\rightarrow$ Social control = Collective efficacy

**Social control:** Readiness of individuals in the community to take action on issues that affect the area/neighbourhood.

**Social cohesion:** Shared values, feelings of solidarity, mutual trust within the community.



# 3 avenues through which social capital may influence health or behaviour

- Social contagion: Behaviours spread more quickly in cohesive networks (more frequent contact).
- Collective efficacy: Greater capacity and willingness of group to work towards common goal through collective action (eg. creating green spaces, improving environment).
- Informal social control: Ability of the group to maintain social order and intervene when deviant behaviour observed.



## **<u>Structural</u>** aspects of social relationships at the individual level

The **quantitative** dimensions of relationships. For eg:

- Number & diversity of people in **social networks**
- Frequency & duration of contact with people in network.
- Structural aspects sometime applied to **social participation** in organisations or social activities.
- Social engagement often used to refer to participation in social activities – egs., membership of voluntary organisations / religious affiliation -- and relationships more broadly.
- Social isolation a lack of structural aspects of relationships.



# **Functional** aspects of social relationships at the individual level

The **qualitative** dimensions of or **resources** derived from interactions and relationships.

At the individual level includes:

- Positive emotional support: egs. caring, understanding, sympathy
- Negative emotional support: eg. conflict
- **Practical** or **instrumental support:** eg. helping with needs doing tasks, lending money.
- Informational support: eg. providing advice or information



# **Functional aspects of social relationships at individual level con't.**

- Supportive actions but also perceived availability are important.
- 'Closeness' how close the relationship feels.
- Loneliness a lack of functional aspects of relationships or 'perceived' social isolation.



## Partnership (usually marriage) as a special case

- Main focus on marriage per se, some distinguish differences between cohabiting & married couples, increasing the two are combined.
- Structural & functional dimensions also studied
  - Structural: longitudinal data allows for studies of duration of states, timing & number of transitions.
  - Functional: relationship quality & closeness.
- Strong links with socioeconomic advantage



## Social relationships over the life course

- Relative importance of different dimensions of social relationships may change with age.
- Life course transitions may act as pivotal moments for shifting the focus of relationships.
- The Convoy Model (Toni Antonucci) People bring their social relationships with them through life.
- Socioemotional Selectivity Theory (Laura Carstensen) Structural aspects decline with age accompanied by shift towards maintaining closest relationships.
- Older age of particular interest -- Retirement, widowhood, onset of functional limitations or health problems may increase risk of social isolation & loneliness.



## Loneliness mainly an issue for older people?



Lasgaard et al. Soc Psychiatry Psychiatr Epidemiol 2016



## **Social Relationships & Mortality / Health**



## Emile Durkheim 1858-1917 Study of suicide & social integration

"Suicide varies inversely with degree of integration of the social groups of which the individual forms a part."

-- Suicide: a Study in Sociology

- Suicide rates higher in protestant countries than in catholic countries.
- Social integration the extent to which individuals are linked to and feel allegiance to social groups.
- Religious groups, family groups and political or nation groups possess the quality of social integration.



## **Social relationships & Health**

- Main effects model: social connectedness is beneficial irrespective of whether one is under stress.
- Stress buffering model: social connections benefit health by providing psychological and material resources needed to cope with stress

Cohen S. Social Relationships and Health. American Psychologist, Vol 59(8), Nov 2004, 676-684.



## Meta-analysis of 70 studies of loneliness & social isolation as risk factors for mortality



"Current evidence indicates that heightened risk for mortality from a lack of social relationships is greater than that for obesity."

Holt-Lundstad et al. Perspectives Psych Sci 2015



Study					
	Odds ratio	Lower	Upper	Z-Value	p-Value
Anstey 02	1.557	1.308	1.854	4.978	0.000
Avlund 04	1.714	1.120	2.623	2.484	0.013
Barefoot 05	1.158	0.916	1.465	1.225	0.221
Berlenan 04	4.998	2.765	9.033	5.328	0.000
Berleman 79	1.829	1.390	2.407	4.314	0.000
Birket-Smith 89	1.441	0.760	2.729	1.120	0.263
Bowling 89	1.664	1.206	2.294	3.104	0.002
Bygren 96	1.505	1.310	1.730	5.761	0.000
Case 92	1.984	1.213	3.244	2.729	0.006
Cassileth 88	0.902	0.565	1.615	-0.108	0.914
Celhen 87	1.631	2.163	3.425	5,495	0.154
Comman 03	1.183	1.052	1.331	2,800	0.005
Daloard 98	1,261	0.940	1.692	1.547	0.122
Devina 90	0.775	0.372	1.616	-0.680	0.497
Eng 02	1.525	1.366	1.702	7.536	0.000
Engedal 96	1.861	1.252	2.765	3.074	0.002
Funch 83	1.186	0.718	1.960	0.668	0.504
Giles 05	1.229	1.020	1.480	2.168	0.030
Glass 99	2.462	1.961	3.091	7.767	0.000
Goldman 95	1.349	1.206	1.508	5.246	0.000
Goodwin 96	1.859	1.246	2.773	3.039	0.002
Greenfield 02	1,462	1.122	1.905	2.815	0.005
Greenwood 95	1.530	1.098	2.130	2.515	0.012
Gustafsson 96	1.273	0.882	1.836	1,289	0.197
Hall 93	1.200	0.933	1,000	1.510	0.131
House oz	1.513	1.433	1 723	9.617	0.000
ithamen 05	1.818	1 207	2 739	2 861	0.004
invine 99	1.009	0.544	1.871	0.029	0.977
Juon 03	1.820	0.922	3.593	1.726	0.084
Kaplan 88	2.119	1.504	2.986	4.291	0.000
Kawachi 96	1.644	1.183	2.285	2.958	0.003
Keller 03	1.701	1,282	2.255	3.688	0.000
Kiely 00	1.254	0.991	1.586	1.883	0.060
Kroenke 06	1,573	1.022	2.421	2.059	0.039
La Cour 06	1.564	1.175	2.082	3.062	0.002
Lennartsson 01	1,493	1.081	2.063	2.430	0.015
Lund 00	1.346	0.895	2.023	1.428	0.153
Lund 02	1,443	1.065	1.975	2.254	0.022
Wateres GE	1.350	1.482	2.069	6,000	0.000
Munis 03	2,259	1.040	4 909	2.058	0.040
Nakanishi 00	1,298	1.053	1.585	2 559	0.011
Nordentoft 93	1.525	1,212	1.918	3.607	0.000
Oman 98	1.223	0.980	1.526	1.779	0.075
Orth-Gomer 87	3.721	3.238	4.277	18.507	0.000
Orth-Gomer 90	2.373	1.081	5.207	2.155	0.031
Parkenson 00	5.207	1.061	16.324	2.830	0.005
Rasulo 05	1.121	0.945	1.329	1.310	0.190
Rodriguez-Artalejo 06	1.184	0.625	2.243	0.518	0.604
Roy 96	2.145	1.605	2.866	5.155	0.000
Rozzini 91	2.563	1.732	3.792	4.705	0.000
Ruberman 84	1.481	1.276	1.719	5.171	0.000
schoenbach 86	2.217	1.530	3.211	4.212	0.000
shmotkin 03	0.913	0.722	1.155	-0.758	0.448
snye 95	2.230	1.480	3.309	3.837	0.000
Supply 02	1.150	1,803	2.349	16.341	0.000
Turker 95	1.305	1 034	1.651	2 217	0.027
Voat 92	1,226	1,050	1.420	2 7 20	0.007
Water-Morison 91	1,306	0.650	2,624	0.750	0.453
Weihs 05	1.837	0.842	4.007	1.528	0.127
	1.572	1.455	1.700	11.391	0.000



Holt-Lunstad J, Smith TB, Layton JB (2010) Social Relationships and Mortality Risk: A Meta-analytic Review. *PLOS Medicine* 7(7): e1000316. https://doi.org/10.1371/journal.pmed.1000316

http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1000316



#### Berkman & Krishna's Conceptual models of how social networks impact health.



Chapter: Social Network Epidemiology Author(s): Lisa F. Berkman and Aditi Krishna From: Social Epidemiology



## Mean increase in <u>cortisol</u> between waking and 30 min later in relation to loneliness tertile.



Source: Steptoe et al. PNEC 2004

Values are adjusted for waking cortisol value, sex, grade of employment, smoking, and <u>body mass index</u>.



#### Association between loneliness & social isolation & inflammation in ELSA (cross-sectional at wave 2). (N = 5,899)



Loneliness & social isolation mutually adjusted + adjusted for age, gender, limiting long-standing illness, depressive symptoms, marital status & wealth.



## Association between loneliness & social isolation & blood pressure in ELSA (cross-sectional at wave 2). (N = 8,688)

Systolic blood pressure



Loneliness & social isolation mutually adjusted + adjusted for age, gender, limiting long-standing illness, depressive symptoms, marital status & wealth.



### Work from SocB student rotation – Emma Walker, *Brain, Behaviour & Immunity*

	CRP	Fibrinogen	WBC	IGF-1
Fuly-adjusted*	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)	Coef (95% CI)
Social	-0.01	-0.01	-0.04	-0.03
engagement	(-0.02 to 0.001)	(-0.02 to -0.003)	(-0.08 to -0.002)	(-0.12 to 0.07)
Living with somebody	-0.06	-0.10	-0.24	0.32
	(-0.10 to -0.02)	(-0.15 to -0.05)	(-0.42 to -0.06)	(-0.2 to 0.8)
Low	-0.004	-0.001	-0.01	0.13
Ioneliness	(-0.02 to 0.01)	(-0.01 to 0.01)	(-0.06 to 0.01)	(0.03 to 0.24)

\*time invariant factors, marital status, employment status, wealth, chronic illness, chronic pain, alcohol consumption, smoking and sedentary behaviours, depression

Prospective associations of social integration with biomarkers of physiological functioning over the life course.



Yang Claire Yang et al. PNAS 2016;113:578-583



## Mediation in social isolation $\rightarrow$ mortality

#### Social isolation

#### All-cause mortality



#### **Circulatory system diseases**

Adjustment	SHR (95% CI)	PERM
Minimally*		
Biological factors	- <b>-</b> 1.62 (1.53-1.71)	9%
Health behaviours	- <b>-</b> 1·44 (1·37-1·52)	35%
Depressive symptoms	- <b>-</b> 1.56 (1.48-1.65)	17%
Cognitive performance	- <b>-</b> 1.65 (1.56-1.74)	4%
Socioeconomic factors	- <b>-</b> 1·44 (1·37-1·53)	34%
Health	- <b>-</b> 1·47 (1·39-1·55)	31%
All	- <b>-</b> 1·24 (1·17-1·31)	64%
0.91	1.0 1.5 2.0 2.5	
Other causes		
Adjustment	SHR (95% CI)	PERM
Minimally*	- <b>-</b> 1·57 (1·48-1·66)	
Biological factors	- <b>-</b> 1.52 (1.43-1.61)	8%
Health behaviours	- <b>-</b> 1·36 (1·28-1·44)	36%
Depressive symptoms	- <b>-</b> 1·48 (1·40-1·57)	14%
Cognitive performance	- <b>-</b> 1·54 (1·45-1·64)	4%
Socioeconomic factors	- <b>-</b> 1·38 (1·30-1·47)	32%
Health	- <b>-</b> 1·39 (1·31-1·47)	31%

### Neoplasms

Majosemene		5111 (55% 61)	I LIVIN	najosemene		5111 (55% 61)	
Minimally*		2.06 (1.92-2.20)		Minimally*	-#-	1.57 (1.48-1.66)	
Biological factors		1.89 (1.76-2.04)	16%	Biological factors	-#-	1.52 (1.43-1.61)	8%
Health behaviours	-8-	1.72 (1.59–1.84)	33%	Health behaviours	-#-	1.36 (1.28–1.44)	36%
Depressive symptoms		1.83 (1.69-1.97)	22%	Depressive symptoms	-#-	1.48 (1.40–1.57)	14%
Cognitive performance		2.00 (1.86-2.15)	6%	Cognitive performance		1.54 (1.45-1.64)	4%
Socioeconomic factors	-8-	1.63 (1.51-1.75)	41%	Socioeconomic factors		1.38 (1.30-1.47)	32%
Health	-8-	1.67 (1.55-1.79)	37%	Health		1.39 (1.31-1.47)	31%
All		1.32 (1.22–1.43)	70%	All	-∎-	1.22 (1.15–1.29)	62%
0.91	·0 1·5 2·0	2.5		0.9 1.0	1.5 2.0	2.5	

DEDW

Figure 1: Proportions of the social isolation-mortality association attributable to biological, behavioural, and psychological factors HR=hazard ratio. PERM=percentage of excess risk mediated. SHR=sub-hazard ratio. \*Adjusted for age, sex, ethnic origin, and chronic disease.

SHR (05% CI)

#### Elovaninio et al. Lancet 2017



## Mediation in loneliness $\rightarrow$ mortality

#### Loneliness

#### All-cause mortality



#### Circulatory system diseases

Adjustment			SHR (95% CI)	PERM
Minimally*			1.30 (1.21-1.39)	
Biological factors	<b></b>		1.24 (1.15-1.33)	20%
Health behaviours			1.15 (1.07–1.24)	48%
Depressive symptoms	┼┲╌		1.07 (0.99–1.15)	77%
Cognitive performance	_ <b>_</b>		1.28 (1.19–1.37)	6%
Socioeconomic factors	│ _∎_		1.15 (1.07-1.23)	49%
Health	┼╋╌		1.06 (0.99–1.14)	79%
All –	+		0.95 (0.88-1.02)	118%
0-8 1	·0 1·2	1.6	2.0	

#### Noonlasme

Neopiasins						other causes				
Adjustment				SHR (95% CI)	PERM	Adjustment			SHR (95% CI)	PERM
Minimally*				— 1·75 (1·61–1·91)		Minimally*			1.24 (1.15-1.34)	
Biological factors				1.58 (1.45-1.72)	24%	Biological factors			1.19 (1.10-1.28)	22%
Health behaviours		_	-	1.51 (1.39-1.65)	32%	Health behaviours	-∎-		1.11 (1.03-1.20)	53%
Depressive symptoms				1.30 (1.19-1.43)	60%	Depressive symptoms	╞╼╌		1.08 (1.00-1.17)	65%
Cognitive performance				- 1.71 (1.56-1.86)	6%	Cognitive performance	_∎_		1.22 (1.13-1.32)	7%
Socioeconomic factors			-	1.44 (1.32-1.58)	41%	Socioeconomic factors	-∎		1.12 (1.04-1.21)	50%
Health		_∎		1.29 (1.18–1.41)	61%	Health	-∤∎		1.04 (0.96–1.12)	84%
All	⊢	-		1.09 (0.99–1.20)	88%	All -	╼╡╴		0.97 (0.89–1.05)	113%
0-8	1.0	1.2	1.6	2.0		0-8	1.0 1.2	1.6	2.0	

Other causes

...

6%

Figure 2: Proportions of the loneliness-mortality association attributable to biological, behavioural, and psychological factors HR=hazard ratio. PERM=percentage of excess risk mediated. SHR=sub-hazard ratio. \*Adjusted for age, sex, ethnic origin, and chronic disease.



### Positive relations as buffer against stress.





Mean changes in plasma <u>fibrinogen</u> between baseline and stress blood samples by tertiles of loneliness.



Source: Steptoe et al. PNEC 2004

Adjusted for sex, grade of employment, smoking, control at work.



## Does social support moderate associations between stress and BP?



Age, gender, household income, body mass, posture, activity level, a prior meal and time (e.g., first, second reading) *Source: Bowen et al. Health Psychol 2014* 



### **Gender & Social Relationships**

- Women have larger social networks, more social support.
- Women's greater social integration may contribute to their greater longevity.
- Marriage is more important as a source of support for men.
  - Men gain the benefits of marriage without the cost of domestic & caregiving responsibilities.
- Will weakening gender norms and changing nature of partnerships – women no longer economically dependent on marriage -- reverse findings above?
  - Some evidence for 'yes' (Rogers et al. 2010; Stohschein et al. 2005; Uecker 2013; Umberson & Williams 2005; Williams 2003)



### **Gender & Social Relationships**

- Why are social relationships more important for women than men?
  - Evolutionary perspective: Women had responsibility for care of immature offspring – greater need than men to be able to turn to social group for protection in times of threat.
  - Sociological perspective: Gender norms & social institutions structure and legitimate competitiveness amongst boys and intimacy & nurturing amongst girls.
- Are women more 'reactive' to their relationships? Perhaps psychologically, but not physically.
  - Associations stronger for mental health
  - But not CVD, mortality or cognitive outcomes.
  - For inflammation may be stronger for men



## Social networks are associated with fibrinogen concentration in elderly men.

TABLE 3. Odds Ratios (OR) and R <sup>2</sup> Values for Elevated Fibrinogen Concentrations (in the Highest Concentration Quartile >336 mg/dl) According to Social Network (SN) Quartile												g/dl)
	Model 1					Model 2				Model	3	
	OR	95% CI	p	R <sup>2</sup>	OR	95% CI	p	R <sup>2</sup>	OR	95% CI	p	R <sup>2</sup>
SN Quartile, Men												
4 (high; n = 122)	1.0			0.03	1.0			0.06	1.0			0.12
3 (n = 87)	1.70	0.86-3.36	.12		1.73	0.86-3.47	.12		1.68	0.81-3.46	.16	
2(n = 92)	2.09	1.08-4.02	.03		2.31	1.16-4.63	.02		2.25	1.09-4.69	.03	
1 (low; n = 74)	2.40	1.21-4.75	.01		2.61	1.26-5.42	.01		2.29	1.07-4.89	.03	
SN Quartile, Women												
4 (high; n = 121)	1.0			0.01	1.0			0.05	1.0			0.10
3(n = 104)	1.07	0.59-1.93	.83		1.10	0.60-2.07	.72		0.97	0.51-1.83	.92	
2(n = 118)	1.11	0.63-1.97	.79		1.14	0.63-2.07	.67		1.10	0.59-2.06	.76	
1 (low; n = 82)	0.78	0.40-1.50	.31		0.67	0.33-1.36	.26		0.57	0.27-1.21	.15	

CI = confidence interval; SN = social networks.

Model 1, no adjustment; Model 2, adjusted for age, race, education, co-morbidity, and physical functioning; Model 3, adjusted for age, race, education, co-morbidity, physical functioning, depression, smoking, alcohol consumption, physical activity, body mass index and depression.



Loucks, Eric; Berkman, Lisa; Gruenewald, Tara; Seeman, Teresa Psychosomatic Medicine. 67(3):353-358, 2 May/June 2005.



## Social networks are associated with C-Reactive Protein concentration in elderly men.

Odds ratios for elevated C-reactive protein (CRP) concentrations (in highest concentration quartile >3.19 mg/L) according to social network quartile in MacArthur Successful Aging Study, 1988–1989

Model Adjustment							
Una	adjusted	Age and l	Race/Ethnicity	Clinical Risk Factors			
OR	95% CI	OR	95% CI	OR	95% CI		
1.00		1.00		1.00			
1.74	0.90-3.36	1.91	0.97-3.76	1.46	0.71-2.99		
1.70	0.89-3.27	2.18*	1.09-4.34	1.57	0.75-3.29		
2.18*	1.17-4.42	2.90*	1.41-5.96	2.23*	1.05-4.76		
1.00		1.00		1.00			
1.17	0.63-2.14	1.28	0.69-2.38	1.21	0.62-2.37		
0.99	0.54-1.80	1.06	0.58-1.96	1.22	0.62-2.38		
1.00	0.52-1.95	1.13	0.56-2.20	0.93	0.43-1.99		
	Un: OR 1.00 1.74 1.70 2.18* 1.00 1.17 0.99 1.00	Unadjusted OR 95% CI 1.00 1.74 0.90–3.36 1.70 0.89–3.27 2.18* 1.17–4.42 1.00 1.17 0.63–2.14 0.99 0.54–1.80 1.00 0.52–1.95	$\begin{tabular}{ c c c c c } \hline Model \\ \hline Unadjusted & Age and I \\ \hline OR & 95\% CI & OR \\ \hline 1.00 & 1.00 \\ 1.74 & 0.90-3.36 & 1.91 \\ 1.70 & 0.89-3.27 & 2.18* \\ 2.18* & 1.17-4.42 & 2.90* \\ \hline 1.00 & 1.00 \\ 1.17 & 0.63-2.14 & 1.28 \\ 0.99 & 0.54-1.80 & 1.06 \\ 1.00 & 0.52-1.95 & 1.13 \\ \hline \end{tabular}$	$\begin{tabular}{ c c c c c c } \hline Model & Adjustment \\ \hline Unadjusted & Age and Race/Ethnicity \\ \hline OR & 95\% CI & OR & 95\% CI \\ \hline 1.00 & 1.00 & \\ 1.74 & 0.90-3.36 & 1.91 & 0.97-3.76 \\ 1.70 & 0.89-3.27 & 2.18* & 1.09-4.34 \\ 2.18* & 1.17-4.42 & 2.90* & 1.41-5.96 \\ \hline 1.00 & 1.00 & \\ 1.17 & 0.63-2.14 & 1.28 & 0.69-2.38 \\ 0.99 & 0.54-1.80 & 1.06 & 0.58-1.96 \\ 1.00 & 0.52-1.95 & 1.13 & 0.56-2.20 \\ \hline \end{tabular}$	$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$		

Clinical risk factors included age, race/ethnicity, socioeconomic status, cardiovascular disease, other major/chronic conditions (diabetes, high blood pressure, cancer, and broken bones), physical functioning, smoking, alcohol consumption, physical activity, body mass index, and depression.

\* Statistically significant (p < 0.05).



## Social networks and C-Reactive Protein in the NHANES.

Social network index						Social network index				
	4: most ties	: most ties 3		0, 1: fewest ties		4: most ties	3	2	0, 1: fewest ties	
	OR	OR (95 % CI)	OR (95% CI)	OR (95% CI)		OR	OR (95 % CI)	OR (95% CI)	OR (95% CI)	
Age 20-59 y	ears (N = 464	9)			Age 20-59 y	ears (N = $542$	(3)			
Model 1 <sup>a</sup>	1.00	0.93 (0.57-1.52)	1.18 (0.84–1.66)	1.20 (0.79–1.81)	Model 1 <sup>a</sup>	1.00	1.06	1.03 (0.80-1.34)	1.38 (1.04–1.85)	
Model 2 <sup>b</sup>	1.00	0.86 (0.53-1.40)	0.96 (0.67-1.38)	0.93 (0.62-1.39)	Model 2 <sup>b</sup>	1.00	1.05	0.88	1.22	
Age ≥60 yea	ms(N = 2323)	)	-		Age ≥60 ve:	ars (N=2423)	(	(,	(,	
Model 1 <sup>a</sup>	1.00	1.37 (0.88-2.13)	1.74 (1.19-2.55)	2.09 (1.37-3.21)	Model 1 <sup>a</sup>	1.00	1.12 (0.81-1.56)	1.17 (0.78–1.77)	1.15 (0.74–1.79)	
Model 2 <sup>b</sup>	1.00	1.29 (0.83–2.03)	1.54 (1.04–2.28)	1.80 (1.11–2.92)	Model 2 <sup>b</sup>	1.00	1.06 (0.75-1.49)	1.00 (0.66–1.50)	0.91 (0.57-1.46)	

OR = odds ratio; CI = confidence interval.

"Model 1 adjusted for age and race or ethnicity.

<sup>b</sup>Model 2 adjusted for age, race or ethnicity, education, smoking status, alcohol use, physical activity, body mass index, hypertension, total cholesterol concentration, and self-reported diabetes mellitus.

#### Men

OR = odds ratio; CI = confidence interval.

"Model 1 adjusted for age and race or ethnicity.

<sup>b</sup>Model 2 adjusted for age, race or ethnicity, education, smoking status, alcohol use, physical activity, body mass index, hypertension, total cholesterol concentration, and self-reported diabetes mellitus.

#### Women



## **SUMMARY: Social relationships & biology**

### MAIN EFFECTS:

- Structural aspects association with inflammation and blood pressure, adiposity for younger people?
- Loneliness effects attenuated by depressive symptoms (physical health).

BUFFER EFFECTS: Some evidence that inflammatory and blood pressure responses to stress greater for those with fewer social ties, less support or greater loneliness.

GENDER DIFFERENCES: Some evidence of higher inflammation for those with fewer social ties for men but not women.