



**Manchester
Metropolitan
University**

Wright, Hayley and Jenks, Rebecca A and Lee, David M (2019) Sexual expression and cognitive function: gender-divergent associations in older adults. *Archives of Sexual Behavior*, 49. pp. 941-951. ISSN 1573-2800 (In Press)

Downloaded from: <http://e-space.mmu.ac.uk/622727/>

Version: Accepted Version

Publisher: Springer (part of Springer Nature)

Please cite the published version

<https://e-space.mmu.ac.uk>

Sexual expression and cognitive function: gender-divergent associations in older adults

Hayley Wright*¹, Rebecca A. Jenks², David M. Lee³

¹ Centre for Advances in Behavioural Science; Coventry University; UK

² School of Psychological, Social and Behavioural Sciences; Coventry University; UK

³ Faculty of Health, Psychology and Social Care; Manchester Metropolitan University; UK

* Corresponding author: hayley.wright@coventry.ac.uk

Abstract

Prior research demonstrates a positive association between sexual activity and cognitive function in later life. However, the relationship between the type of sexual activity and cognitive function in older adulthood remains unclear. This study explores the associations between the frequency of engaging in different types of sexual activities (intercourse, masturbation, and kissing/petting/fondling) and cognitive function in older women and men. Using data from Wave 6 of the English Longitudinal Study of Ageing (ELSA), 1915 women and 2195 men (age range 50-89 years; $n = 4110$) reporting any type of sexual activity over the past 12 months, were included in the study. Multiple regression controlling for age, education, satisfaction with sex life, cohabiting, wealth, general health, physical activity, depression and loneliness, was used to explore the associations between the frequency of engagement in intercourse, masturbation and kissing/petting/fondling, and two measures of cognitive function; word recall and number sequencing. For women, masturbation was linked to better word recall ($p = .008$), whilst for men, kissing/petting/fondling was associated with better number sequencing ($p = .035$). In women ($p = .016$) and men ($p = .018$), dissatisfaction with sex life was associated with better number sequencing. The results point to gendered links between sexual activity and cognitive function. These gender-related divergences may reflect differences in biological/neurological mechanisms, or in cognitive lifestyle factors that could influence cognitive reserve in later life. This novel study underscores the need to delineate the underlying mechanisms of the association between sex and cognition in men and women.

Keywords: cognition; sexual activity; gender differences; later life; ELSA

Introduction

Engagement in leisure activities, including mental, social and physical activities, has a dose-response relationship with cognitive function in older adults, where increasing engagement in more than one type of activity is associated with slower rates of cognitive decline and reduced risk of dementia (Fratiglioni, Paillard-Borg, & Winblad, 2004; Karp et al. 2005; Wang et al., 2013, Marioni et al. 2015). These findings converge with the cognitive reserve hypothesis, which suggests that our lifelong experiences and choice of activities can determine our rate of cognitive decline and hence whether we develop dementia, regardless of the presence of neuropathological changes (Stern, 2012; Katzman et al., 1988). Thus, higher levels of education, cognitively challenging occupations and engaging in social activities (i.e. the main components of our ‘cognitive lifestyle’) are all linked to increased resilience to cognitive decline and dementia in later life (Valenzuela et al., 2013, Scarmeas & Stern, 2003).

Wang et al. (2013) followed 1463 adults over the age of 65 years over a 2.4 year period in a Chinese longitudinal population-based cohort study of ageing. Participants undertook a cognitive assessment in four domains (global cognition, episodic memory, language and executive function) and leisure activity assessment at baseline and follow up. After adjusting for age, gender, education, household composition, alcohol intake, smoking, medical history, APOE ϵ 4 carrier status and BMI, Wang et al. (2013) found that mental, social and physical activities affected different domains of cognitive function. Higher levels of mental activity were associated with less decline in global cognition, language and executive function; higher levels of physical activity were linked to less decline in episodic memory and language; and higher levels of social activity were associated with less decline in global cognition. Three hypotheses are proposed to account for the association between leisure activities and cognition (see Fratiglioni et al. 2004 for an overview), with the most

relevant being the cognitive reserve hypothesis as discussed above. Further, the vascular hypothesis posits that mental, social and physical activities have beneficial effects on cognition by reducing the cardiovascular risk factors that are associated with the progression of dementia and Alzheimer's Disease (AD; see Kivipelto et al., 2001). Finally, the stress hypothesis states that increased engagement with others leads to more positive emotional states (such as self esteem, social competence and mood) that lower stress, where increased proneness to psychological distress is linked to increased risk of developing AD (see Wilson, Evans, Bienias, Mendes de Leon, Schneider, & Bennett, 2003). Furthermore, Wang et al. (2013) reported that whilst mental, social and physical activities were all protective against cognitive decline in women, it was only mental and physical activities, but not social activities, that were linked to slower cognitive decline in men. This finding highlights the potential importance of gender-specific analyses when investigating cognitive ageing, and the possible underlying mechanisms or hypotheses of cognitive decline and dementia.

Sexual activity comprises elements of mental, social and physical activity, so it is feasible to assume that sex may carry some of the same benefits to health and wellbeing as those typically investigated as part of a healthy cognitive lifestyle in later years. Indeed, recent research from the English Longitudinal Study of Ageing (ELSA) shows that sexual and intimate relationships in later life are associated with better physical health and wellbeing (Lee, Vanhoutte, Nazroo, & Pendleton, 2016). Dominguez and Barbagallo (2016) also argue that sexuality has implications for physical, psychological and biological health, and remind us that sexuality is closely related to socio-cultural norms and health practices across the lifespan. These recent examples of research further demonstrate the significance of sex and sexuality to many dimensions of health and wellbeing in later life, and highlight the impending need to consider sexual health and activity as legitimate and necessary components of contemporary ageing research.

The ageing research landscape is changing with the gradual inclusion of sex and sexuality matters, and there have been a few key studies in recent years demonstrating significant links between sex and cognitive health (see below, Wright & Jenks, 2016; Wright, Jenks, & Demeyere, 2017). Given the overlap between sexual activity and the mental, social and physical activities discussed above, it is imperative that we further investigate why this association between sex and cognition exists, to better understand sex and sexuality as a potentially modifiable lifestyle factor in the promotion of healthy cognitive ageing.

Wright and Jenks (2016) was the first study of its kind to demonstrate a significant association between sexual activity and cognitive function in healthy older men and women. This study used newly available data from ELSA and showed that those who reported being sexually active in the past 12 months had better scores on cognitive tests than those who reported that they had not been sexually active. In a different sample of older adults, Wright et al. (2017) explored whether the frequency with which people engaged in non-specific sexual activity was important in the association with a range of cognitive domains. This novel study revealed a cognitive *domain-specific* association between frequent (weekly) sexual activity and verbal fluency and visuospatial performance, similar to the domain-specific findings of Wang et al. (2013) in relation to leisure activities as described above. Until now, these studies (Wright & Jenks, 2016; Wright et al., 2017) have considered ‘sexual activity’ as a single entity, encompassing all penetrative and non-penetrative activities (e.g. sexual intercourse, masturbation and kissing/petting/fondling) in one general factor. However, the findings (Wright & Jenks, 2016; Wright et al., 2017) have generated further research questions regarding whether all types of sexual activities (i.e. penetrative and non-penetrative) are related to cognitive function in a similar way. For example, it is not yet known whether partnered sexual intercourse has the same association with cognition as a predominately solo sexual activity, such as masturbation. Investigating this question will

allow us to interpret with greater certainty whether the benefit of sexual activity is driven by a biological element (such as a surge in dopamine or 'feel-good' hormones) associated with sexual arousal, or whether it is the partnered aspect of sex that is important for cognition (in a similar way to social activities or companionship, for example). Therefore, whilst Wright and Jenks (2016) explored cognitive differences in those who were categorised as sexually active or not, the current study will focus on those who report being sexually active, and delineate the different types of sexual activities and associations with cognitive function.

There are different theories about the likelihood of engaging in different types of sexual activities, and engagement in different types of sexual activities is often interdependent. The compensatory model suggests that masturbation acts as a substitute for sexual desires that are unfulfilled by paired sexual activity (Dekker & Schmidt, 2003). The complementary model suggests that masturbation enhances sexual activity rather than replacing it, where partnered sex stimulates the desire for additional activities (Dekker & Schmidt, 2003). Regnerus, Price and Gordon (2017) found support for the compensatory model for men, and the complementary model for women, but both are mediated by satisfaction. Indeed, in a national sample of 15,738 adults across the United States, Regnerus et al. (2017) report that satisfaction with sex life and partnered status were both stronger predictors of masturbation than partnered sex. This study offers an interesting reflection on the interdependency of sexual activities and satisfaction, and demonstrates the importance of considering subjective satisfaction as a potential mediator in sexual activity focussed research. However, the survey used in the Regnerus et al. (2017) study comprised of adults aged between 16 and 60 years, so the findings are not necessarily representative of the older population, and may under-represent or omit other intimate behaviours of this demographic. For example, kissing and touching are also important behaviours in the intimate relationships of older people but are often overlooked (Ginsberg, Pomerantz, & Kramer-Feeley, 2005).

Older adults who experience sexual dysfunction may still engage in kissing, cuddling and touching with their partner to maintain intimacy and emotional closeness.

In light of the recent findings outlined above, the current study aims to determine whether different types of sexual activity (namely intercourse, masturbation and kissing/petting/fondling) and satisfaction with sex life, are differentially associated with cognitive functions in older women and men. Wright and Jenks (2016) reported a significant association between sexual activity and number sequencing and recall in men, but only a significant association between sexual activity and recall (not number sequencing) in women. Therefore, while we expect to find gender differences in the associations between cognition and sexual activity in the current study, it is an open question as to which of the specific sexual activities will be implicated in these associations.

Methods

Participants

Data were drawn from the English Longitudinal Study of Ageing (ELSA), which is a large, nationally representative cohort study of community-dwelling men and women aged 50 years and above in England (www.elsa-project.ac.uk). Data are collected every two years on demographics including health, wealth, lifestyle and cognitive function, via face-to-face interview and self-completion questionnaires (see Steptoe, Breeze, Banks, & Nazroo, 2013 for further cohort profile details). In Wave 6 of ELSA ($N = 10601$), 7079 (67%) participants also completed a comprehensive Sexual Relationships and Activities Questionnaire (SRAQ; see Lee, Nazroo, O'Connor, Blake, & Pendleton, 2015) alongside typical questions on socio-demographics, health, wellbeing and cognitive function. The current analysis was restricted to core ELSA participants who reported any sexual activity over the past year, with

exclusions based upon age <50 or >89 years ($n = 436$)¹; missing sexual activity data ($n = 5759$); declared ‘never’ to all three sexual activities in past month ($n = 250$); and missing cognitive data ($n = 46$). The final sample comprised 1915 women (46.6%) and 2195 men (53.4%), aged 50-89 years ($n = 4110$).

Independent variables

Sexual activities were assessed by: “How often in the past month have you engaged in...” i) sexual intercourse; ii) masturbation; iii) kissing/petting/fondling. Responses were categorised as: weekly (combining responses of ‘once a week’, ‘2-3 times a week’, ‘once a day’ and ‘> once a day’); monthly (combining responses of ‘once in past month’ and ‘2-3 times in past month’); and never (‘not at all in past month’). All participants answered either monthly or weekly to at least one activity.

Dependent variables

Memory was assessed by combining scores on immediate and delayed word recall tasks, to provide a broad ‘memory’ score for the sample, and to maintain consistency with dependant variables used in previous studies of this nature (e.g. Wright & Jenks, 2016). Examiners read aloud a list of ten everyday words (chosen at random from 4 possible lists to avoid order effects of repeat testing) at a rate of one word per two seconds, and the respondents were asked to recall as many words as possible straight away (immediate recall), and again after a short delay of a few minutes (delayed recall). Respondents could score a maximum of 10 on each test, which were summed to give an overall recall score with a minimum of zero and a maximum of 20. There were four word lists available, but only one was chosen at random by the computer for each respondent.

¹ In ELSA, respondents aged 90 and above were coded with an arbitrary age of 99 years to protect anonymity, which for our purposes, gives an inaccurate representation of age within the oldest portion of the sample. Survey responses were collected from participants under the age of 50 years (i.e. younger partners of core ELSA respondents), but these were not nationally representative of the less than 50 age group.

Participants also completed a number sequencing task, which is used as a brief measure of executive function in ELSA (e.g. comprising elements of pattern detection, mental arithmetic and problem solving). The examiner read aloud a list of numbers and a 'blank', where the respondent was required to identify the pattern in the sequence of numbers and use this pattern to determine the blank (e.g. in the sequence "2, 4, 'blank', 8" the correct answer would be '6'). The test was block-adaptive, where the administration was adapted depending on the ability of the respondent. Fifteen items were grouped into five blocks of three items by item difficulty level. Each respondent was asked the same first three items, which consisted of an easier item, a moderately difficult item, and a more difficult item. Based on the number of items answered correctly in the first block, respondents were then asked one of four remaining sets (each containing three items): the easiest set, a somewhat easy set, a more difficult set, or a most difficult set. A score for both sets was calculated and converted into a standardised score which is available in the ELSA Wave 6 dataset (range 409-584).

Covariates

Covariates were variables that have been shown in previous studies to be related to either cognitive function, sexual activity, or both. Age was measured in years (range 50-89 years), and loneliness was represented by total score on the UCLA three-item loneliness scale (Hughes, Waite, Hawkley, & Cacioppo, 2004) which was asked as part of the ELSA interview and recorded as three separate questions within the dataset. Total loneliness score (range 3-9) was included in the analysis, with a higher score indicating higher levels of loneliness. Highest educational qualification was categorised into three levels as used by Huppert, Gardener and McWilliams (2006): low (no formal qualification), intermediate (A level, O level, CSE, NVQ1/2/3) and high (degree, NVQ4/5, higher education below degree), and net financial wealth quintiles (1st quintile = poorest, 5th quintile = wealthiest) were

provided in the ELSA dataset. Self-reported general health was collapsed into two categories of good (collapsing across the ‘excellent’, ‘very good’, and ‘good’ categories in ELSA) and poor (collapsing across the ‘fair’ and ‘poor’ categories in ELSA) to ensure there were a sufficient number of responses in each of the ‘positive’ (e.g. ‘good’) and ‘negative’ (e.g. ‘poor’) response categories, and physical activity level was categorised as low, moderate or high within the ELSA dataset. Depression was indicated by a score of four or more on the eight-item version of the Centre for Epidemiologic Studies Depression (CES-D) scale (Turvey, Wallace, & Herzog, 1999), or a self-reported diagnosis of depression. Satisfaction with sex life was collapsed into three categories of satisfied (comprising responses of ‘very satisfied’ and ‘moderately satisfied’ from ELSA), neutral (comprising responses of ‘neither satisfied nor dissatisfied’ from ELSA) and dissatisfied (comprising responses of ‘very dissatisfied’ and ‘moderately dissatisfied’ from ELSA) to ensure there were a sufficient number of responses in each of the three main response categories. Married/cohabiting status was recorded in ELSA as a simple ‘yes’ or ‘no’ to the question of ‘living with spouse or partner?’

Statistical Methods

All data were analysed using IBM SPSS version 24.0 (IBM Corp., Armonk, NY, USA) and STATA version 14.2 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP). T-tests and chi-square analyses were used to assess baseline differences between women and men on key characteristics.

Multiple linear regression was performed separately for women and men, and for each dependent variable (i.e. recall and number sequencing scores). Intercourse, masturbation and kissing/petting/fondling, and satisfaction with sex life, were entered simultaneously into the main models. We also modelled each sexual activity individually and include these results as appendices.

Procedure

Data were drawn from Wave 6 of ELSA, and all participants included in this study completed the key questions on the SRAQ and had full cognitive data, as described above. Details of the administration of the ELSA Wave 6 survey and an overview of the main findings have been reported in detail elsewhere (see Banks, Nazroo, & Steptoe, 2014). Since Wright and Jenks (2016) also utilised data from ELSA Wave 6, many of the variables used in that study and the current study are similar. However, it should be noted that the crucial difference lies in the level of detail of the independent variables in the current study. Where Wright and Jenks (2016) distinguished between participants who were sexually active and those who were not in a binary-type fashion, the current study categorises self-report of engagement in three distinct types of sexual activity (i.e. intercourse, masturbation and kissing/petting/fondling), at three levels of frequency (i.e. weekly, monthly, never).

Results

Table 1 summarises the key characteristics of the sample. There were significant differences between women and men on all variables except wealth and cohabiting status.

Table 1

Demographics and scores on key variables of interest for women (n = 1915) and men (n = 2195) included in the study sample (total n = 4110).

Variable	Women (n = 1915)	Men (n = 2195)	p
	<i>Mean (SD)</i>	<i>Mean (SD)</i>	
Age	62.2 (7.3)	64.3 (7.7)	< 0.001
Recall score	12.3 (3.0)	11.2 (3.1)	< 0.001
Number sequencing score	536.8 (24.3)	543.5 (25.5)	< 0.001
Loneliness score	4.1 (1.4)	3.9 (1.3)	0.003
	%	%	
Sexual Intercourse			
Never	27.4	33.8	
Monthly	47.4	41.7	
Weekly	25.2	24.5	< 0.001
Masturbation			

Never	66.4	38.7	
Monthly	28.6	37.0	
Weekly	5.0	24.3	< 0.001
Kissing / Petting / Fondling			
Never	17.5	23.3	
Monthly	31.2	28.1	
Weekly	51.3	48.6	< 0.001
Satisfaction with sex life			
Satisfied	67.0	64.8	
Neutral	20.6	13.8	
Dissatisfied	12.4	21.4	< 0.001
Married/Cohabiting			
Yes	85.7	84.9	
No	14.3	15.1	0.451
Education			
Low	16.0	12.6	
Intermediate	46.4	35.8	
High	37.6	51.6	< 0.001
Wealth (quintiles)			
1 st (poorest)	10.2	11.0	
2 nd	16.1	15.9	
3 rd	19.3	20.0	
4 th	25.5	25.3	
5 th (wealthiest)	28.9	27.8	0.867
General Health			
Poor	17.5	20.2	
Good	82.5	79.8	0.028
Physical Activity			
Low	19.9	17.7	
Moderate	55.9	52.2	
High	24.3	30.2	< 0.01
Depression			
Yes	17.0	10.9	
No	83.0	89.1	< 0.001

Note: Continuous data are presented as mean (SD), categorical data are presented as percentages. T-tests for continuous variables, Pearson chi-square for categorical variables.

Table 2 summarises the fully adjusted multiple regression models, which were all significant.

For brevity, we focus on the variables related to sexual activities and satisfaction (see Table 2, Supplementary Tables 3 and 4).

Table 2

Summary of multiple regression statistics for the key sexual activity predictor variables (frequency of intercourse, masturbation and kissing/petting/fondling) and covariates for recall and number sequencing scores: by gender

WOMEN (n = 1915)				
Recall	B	SE B	β	p
Constant	16.86	0.96		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	0.25	0.25	0.04	0.321
Weekly	0.25	0.28	0.04	0.385
Masturbation (ref: Never)				
Monthly	0.39	0.19	0.05	0.040
Weekly	1.01	0.38	0.07	0.008
Kissing / Petting / Fondling (ref: Never)				
Monthly	0.32	0.28	0.05	0.247
Weekly	0.34	0.27	0.06	0.198
Satisfaction (ref: Satisfied)				
Neutral	0.20	0.19	0.03	0.298
Dissatisfied	0.41	0.24	0.05	0.089
Cohabiting (ref: No)	-0.47	0.27	-0.05	0.079
Age (years)	-0.10	0.01	-0.23	< 0.001
Education (ref: Low)				
Intermediate	0.38	0.20	0.06	0.057
High	1.15	0.22	0.18	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-0.05	0.26	-0.01	0.838
3 rd	0.02	0.25	0.00	0.952
4 th	0.44	0.22	0.06	0.046
5 th (Wealthiest)	0.36	0.22	0.05	0.105
General Health (ref: Poor)	0.97	0.22	0.12	< 0.001
Physical Activity (re: Low)				
Moderate	0.34	0.18	0.06	0.062
High	0.39	0.23	0.05	0.090
Depression (ref: No)	-0.07	0.22	-0.01	0.757
Loneliness score	-0.16	0.06	-0.07	0.009
Number sequencing	B	SE B	β	p
Constant	561.11	7.60		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	-0.31	2.02	-0.01	0.879
Weekly	-0.43	2.24	-0.01	0.849
Masturbation (ref: Never)				
Monthly	0.10	1.49	0.00	0.945
Weekly	1.66	3.01	0.01	0.582
Kissing / Petting / Fondling (ref: Never)				

Monthly	-1.79	2.19	-0.04	0.414
Weekly	0.44	2.12	0.01	0.835
Satisfaction (ref: Satisfied)				
Neutral	-1.15	1.52	-0.02	0.451
Dissatisfied	4.61	1.91	0.06	0.016
Cohabiting (ref: No)	1.93	2.12	0.02	0.363
Age (years)	-0.62	0.09	-0.19	< 0.001
Education (ref: Low)				
Intermediate	5.13	1.60	0.11	0.001
High	14.10	1.76	0.28	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.41	2.06	-0.03	0.241
3 rd	2.43	1.95	0.04	0.213
4 th	4.46	1.75	0.08	0.011
5 th (Wealthiest)	5.09	1.75	0.09	0.004
General Health (ref: Poor)	5.80	1.71	0.09	0.001
Physical Activity (ref: Low)				
Moderate	1.22	1.43	0.03	0.393
High	1.58	1.80	0.03	0.380
Depression (ref: No)	1.96	1.77	0.03	0.268
Loneliness score	-0.74	0.48	-0.04	0.124

MEN (n = 2195)

<i>Recall</i>	<i>B</i>	<i>SE B</i>	β	<i>p</i>
Constant	16.02	0.95		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	0.05	0.27	0.01	0.861
Weekly	0.26	0.30	0.04	0.382
Masturbation (ref: Never)				
Monthly	0.26	0.18	0.04	0.144
Weekly	0.31	0.21	0.04	0.150
Kissing / Petting / Fondling (ref: Never)				
Monthly	0.13	0.29	0.03	0.643
Weekly	0.17	0.28	0.03	0.535
Satisfaction (ref: Satisfied)				
Neutral	-0.04	0.23	-0.01	0.859
Dissatisfied	0.37	0.20	0.05	0.069
Cohabiting (ref: No)	0.16	0.27	0.02	0.561
Age (years)	-0.10	0.01	-0.25	< 0.001
Education (ref: Low)				
Intermediate	0.48	0.23	0.07	0.040
High	1.04	0.23	0.17	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	0.06	0.26	0.01	0.832
3 rd	0.41	0.25	0.05	0.095
4 th	0.43	0.24	0.06	0.065

5 th (Wealthiest)	0.75	0.23	0.11	0.001
General Health (ref: Poor)	0.47	0.22	0.06	0.030
Physical Activity (re: Low)				
Moderate	0.26	0.20	0.04	0.178
High	0.44	0.21	0.06	0.041
Depression (ref: No)	-0.42	0.28	-0.04	0.138
Loneliness score	-0.10	0.07	-0.04	0.136
<i>Number sequencing</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	558.41	7.61		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	-4.54	2.15	-0.09	0.035
Weekly	-1.73	2.42	-0.03	0.476
Masturbation (ref: Never)				
Monthly	0.81	1.42	0.02	0.570
Weekly	0.38	1.70	0.01	0.821
Kissing / Petting / Fondling (ref: Never)				
Monthly	3.03	2.29	0.06	0.187
Weekly	4.54	2.22	0.09	0.041
Satisfaction (ref: Satisfied)				
Neutral	-2.61	1.88	-0.04	0.165
Dissatisfied	3.84	1.62	0.06	0.018
Cohabiting (ref: No)	2.32	2.19	0.03	0.289
Age (years)	-0.48	0.09	-0.14	< 0.001
Education (ref: Low)				
Intermediate	7.44	1.87	0.14	< 0.001
High	14.64	1.83	0.29	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.70	2.11	-0.04	0.200
3 rd	2.29	1.99	0.03	0.249
4 th	6.635	1.89	0.11	< 0.001
5 th (Wealthiest)	9.00	1.85	0.16	< 0.001
General Health (ref: Poor)	8.43	1.72	0.13	< 0.001
Physical Activity (re: Low)				
Moderate	-2.06	1.57	-0.04	0.188
High	-2.55	1.71	-0.05	0.135
Depression (ref: No)	-1.03	2.27	-0.01	0.652
Loneliness score	-1.56	0.55	-2.87	0.004

Note: B = unstandardized beta coefficient; SE = standard error; β = standardised beta coefficient; p = significance value.

For women, self-reported monthly ($M = 12.8$, $SD = 3.1$, $\beta = 0.05$, $p = 0.040$) and weekly ($M = 13.1$, $SD = 3.3$, $\beta = 0.07$, $p = 0.008$) masturbation were associated with higher recall scores compared to those who reported no masturbation ($M = 12.1$, $SD = 3.0$). Findings were similar

when masturbation was the only sexual activity entered into the model (see Supplementary Table 3).

In the fully adjusted model for number sequencing, dissatisfaction with sex life was associated with *higher* number sequencing scores ($M = 542.2$, $SD = 24.0$, $\beta = 0.06$, $p = 0.016$) than being satisfied with sex life ($M = 536.2$, $SD = 23.9$) in women. Sexual activities were not associated with number sequencing scores for women (see Table 2 and Supplementary Table 4).

For men, none of the sexual activities were significantly associated with recall scores (see Table 2 and Supplementary Table 3), although dissatisfaction with sex life was significantly associated with *higher* recall scores ($M = 11.5$, $SD = 3.1$, $\beta = 0.05$, $p = 0.048$) than being satisfied with sex life ($M = 11.3$, $SD = 3.0$) when sexual intercourse only was entered into the model (see Supplementary Table 3).

Monthly sexual intercourse among men was associated with *lower* number sequencing scores ($M = 541.5$, $SD = 26.8$, $\beta = -0.09$, $p = 0.035$) than no sexual intercourse ($M = 543.6$, $SD = 24.9$). Men who reported weekly kissing/petting/fondling ($M = 546.1$, $SD = 24.4$, $\beta = 0.09$, $p = 0.041$) scored higher on number sequencing than those who reported none ($M = 542.6$, $SD = 25.2$). Furthermore, for men, dissatisfaction with sex life was associated with *higher* number sequencing scores ($M = 547.3$, $SD = 25.8$, $\beta = 0.06$, $p = 0.018$) than being satisfied with sex life ($M = 544.1$, $SD = 25.3$). There were similar findings when each sexual activity was added into the model separately (see Supplementary Table 4).

Discussion

The current study was the first to systematically investigate the associations between frequency of intercourse, masturbation, kissing/petting/fondling and two measures of cognitive function in women and men over the age of 50. We also examined the role of satisfaction with sex life, which has been shown to mediate engagement in masturbation and

intercourse (Regnerus et al., 2017). The sexual activity categories in the current study (i.e. intercourse, masturbation, kissing/petting/fondling), were not mutually exclusive as participants were included if they reported engagement in at least one of them, nor was it our intention to measure the co-occurrence of these types of sexual activity in the manner of Regnerus et al. (2017). Rather, we presented each type of sexual activity and satisfaction with sex life as separate variables in our multiple regression analysis to determine whether all factors have similar associations with cognition, to extend knowledge beyond that of previous studies (Wright & Jenks, 2016; Wright et al., 2017). Therefore, rather than directly testing the complementary and compensatory models postulated by Regnerus et al. (2017), we incorporated their hypothesis that satisfaction with sex life may be an important mediator in the type of sexual activities reported, and hence cognitive function.

In the current study, frequent masturbation was associated with higher recall scores in women, and frequent kissing/petting/fondling was associated with higher number sequencing scores in men. In men only, monthly intercourse was associated with *lower* scores on the number sequencing task than no intercourse. Interestingly, dissatisfaction with sex life was associated with *higher* number sequencing scores, in both women and men, and possible mechanisms explaining this are discussed below.

Sexual activities share many of the functions and properties of the mental, social and physical activities that have been the focus of much research over the past 15 years (Fratiglioni, Paillard-Borg, & Winblad, 2004; Karp et al. 2005; Wang et al., 2013, Marioni et al. 2015). Therefore, it is feasible that any of the proposed hypotheses which attempt to explain the link between leisure activities and cognitive function (e.g. cognitive reserve hypothesis, Stern, 2012; cardiovascular hypothesis, Kivipelto et al., 2001; or stress hypothesis, Wilson et al., 2003) could similarly explain the association between sexual activity and cognitive function. Whilst this is encouraging, our current study indicates that

not all sexual activities are associated with cognitive function, and that significant associations between specific sexual activities and cognitive domains are gender-specific. This extends the previous findings of Wright and Jenks (2016) and Wright et al. (2017) in showing that ‘sexual activity’ cannot be treated as one concept, methodologically or practically. Instead, researchers and practitioners in this field must pay attention to the types of intimate activities that older people are engaging in when considering how or why these may be related to cognitive health. The findings of the current study are similar to previous prospective findings in relation to leisure activities (Wang et al., 2013), where all three types of leisure activities were related to slower cognitive decline in women, but only mental and physical activities (and not social activity) were protective of cognitive function in men. That is, in our study, not all types of sexual activities were related to cognitive function in a uniform way across the genders. Therefore, there may be different mechanisms underlying the relationship between sexual activities and cognitive functions between men and women. Possible explanations for this could reflect underlying differences in gender-specific neuroanatomy and/or neurobiological factors (see Furth, Mastwal, Wang, Buonanno, & Vullhorst, 2013; Melis & Argiolas, 1995; Carmichael et al., 1987), although these explanations are difficult to verify, and it is beyond the scope of the ELSA data and the current study to further explore this potential biological account. Neuroimaging studies could be useful here, to measure differences in domain-specific cognitive function and sex-related hormone/neurotransmitter levels in sexually active men and women. Nevertheless, researchers have reported gender differences in cognitive lifestyle in older cohorts (Valenzuela et al., 2013), where older men were more likely to be cohabiting and to have had managerial or professional occupations, but less likely to engage in cognitively stimulating activities such as reading, than older women. Although we did not measure social activities, in our sample, men were indeed more likely than women to report higher levels of occupation

status, but there was no difference between men and women on cohabiting status (see Table 1). Even when previous studies control for the cohabiting factor (Valenzuela et al., 2013), older women were found to be generally more cognitively engaged than older men. Therefore, a potential explanation for the differential associations between masturbation and cognition in women, and kissing/petting/fondling and cognition in men, could be found not in the sexual activities themselves, but in those mediating cognitive lifestyle factors (not measured in the current study) that may influence differential engagement in these types of sexual activity for men and women.

Interestingly, our results showed that dissatisfaction with overall sex life was associated with better number sequencing in both women and men. This may seem counterintuitive given that previous findings show significant associations between frequent sexual activity and better cognitive function (Wright & Jenks, 2016; Wright et al., 2017), but we must be careful not to equate sexual dissatisfaction with infrequent sexual activity, as we cannot verify this in the current study. Satisfaction with sex life is a highly subjective measure, which is open to the interpretation of the individual participant and could be influenced by other factors such as general life satisfaction, transient mood or happiness. Accordingly, we would urge caution when interpreting the significant association between dissatisfaction with sex life and better number sequencing scores, as further validity analyses would need to be explored. It is also worthy to note that the current study included only participants who answered yes to engaging in at least one type of sexual activity over the past year. Therefore, all participants were classed as 'sexually active', which is significantly associated with higher cognitive function regardless of other covariates (Wright & Jenks, 2016; Wright et al., 2017), including satisfaction with sex life.

There are a few factors relating to the current study that should be considered when interpreting the findings. Since this was a cross-sectional study, we cannot infer temporal

associations between sexual activity and cognition. However, as increasing engagement in mental, social and physical activities predict slower rates of cognitive decline (Wang et al., 2013), it is plausible that sexual activity may also have a similar effect, given the overlap between sexual, physical, social and mental activities. ELSA does not include explicit data on sexual orientation, so we cannot conclude whether our results are typical of heterosexual, homosexual and bisexual older adults. Further research using longitudinal data on sexual activity and cognitive function, and dyadic modelling techniques with coupled data would allow greater confidence in the accuracy of self-report data which is often scrutinised in survey studies, and further exploration of the complex interrelationships between different types of sexual activities and satisfaction in intimate relationships. Additionally, the current study does not account for sexual health and sexual dysfunction, which may influence the types of sexual activities that older people can physically engage in. For example, erectile dysfunction may preclude a larger proportion of older men from engaging in sexual intercourse, but prompt increased engagement in kissing/petting and fondling.

Our results show, for the first time, significant gender-specific links between different sexual activities and cognitive functions, which may be driven by differences in neurobiological mechanisms, cognitive lifestyle and cognitive reserve, or other (potentially unmeasured) factors associated with satisfaction with sex life in men and women. The association between sex and cognition in later life is a relatively new area of research, and as such the current explanatory literature is sparse and, as yet, untested. The current study highlights the important roles of gender differences and satisfaction with sex life in research of this nature (i.e. in relation to cognitive function), as well as the necessity to treat specific types of sexual activity and intimacy as distinct factors, rather than including all activities under one umbrella term of 'sex'. Further research exploring the social and biological underpinnings of the association between sex and cognition would be a significant addition to

our growing understanding of modifiable lifestyle factors that can protect cognitive function in later life. Further, healthcare practitioners are urged to consider the importance of conversations around sex and intimacy with older adults, and have a duty to improve the knowledge and attitudes of professionals around sexuality in later life (see Haesler, Bauer, & Fetherstonhaugh, 2016). Providing support for older adult relationships through discussions about sex and intimacy, at routine GP appointments for example, could have further benefits to cognitive health in later life. Given that there is now converging evidence to support a role for sexual activity in cognitive health, and that healthy ageing is a priority for UK and worldwide governments, it is essential that researchers, healthcare professionals and policymakers work together to recognize the importance of sexual health and relationships in later life, to maximise the cognitive health and wellbeing of our global ageing population.

References

- Banks, J., Nazroo, J., & Steptoe, A. (Eds.). (2014). *The Dynamics of Ageing: Evidence from the English Longitudinal Study of Ageing 2002–2012 (Wave 6)*. London: The Institute for Fiscal Studies.
- Carmichael, M. S., Humbert, R., Dixen, J., Palmisano, G., Greenleaf, W., & Davidson, J. M. (1987). Plasma oxytocin increases in the human sexual response. *The Journal of Clinical Endocrinology and Metabolism*, 64(1), 27-31. doi: 10.1210/jcem-64-1-27.
- Dekker, A., & Schmidt, G. (2003). Patterns of masturbatory behaviour: Changes between the sixties and the nineties. *Journal of Psychology & Human Sexuality*, 14 (203), 35-48. doi: 10.1300/J056v14n02_04.
- Dominguez, L. J., & Barbagello, M. (2016). Ageing and sexuality. *European Geriatric Medicine*, 7, 512-518. doi: 10.1016/j.eurger.2016.05.013.
- Fratiglioni, L., Paillard-Borg, S., & Winblad, B. (2004). An active and socially integrated lifestyle in late life might protect against dementia. *Lancet Neurology*, 3, 343-353. doi:10.1016/S1474-4422(04)00767-7.
- Furth, K. E., Mastwal, S., Wang, K. H., Buonanno, A., & Vullhorst, D. (2013). Dopamine, cognitive function, and gamma oscillations: role of D4 receptors. *Frontiers in Cellular Neuroscience*, 7, article 102, 1-19. doi: 10.3389/fncel.2013.00102.
- Ginsberg, T. B., Pomerantz, S. C., & Kramer-Feeley, V. (2005). Sexuality in older adults: behaviours and preferences. *Age and Ageing*, 34(5), 475-80. doi: 10.1093/ageing/afi143.
- Haesler, E., Bauer, M., & Fetherstonhaugh, D. (2016). Sexuality, sexual health and older people: A systematic review of research on the knowledge and attitudes of health professionals. *Nurse Education Today*, 40, 57-71. doi: 10.1016/j.nedt.2016.02.012.

- Hughes, M. E., Waite, L. J., Hawkey, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: results from two population-based studies. *Research on Aging*, 26, 655–672. doi: 10.1177/0164027504268574.
- Huppert F. A., Gardener, E., & McWilliams, B. (2006). Cognitive Function. In *Retirement, Health and Relationships in the Older Population of England: The 2004 English Longitudinal Study of Ageing (Wave2)*, pp. 217-242. Institute for Fiscal Studies: London.
- Karp, A., Paillard-Borg, S., Wang, H. X., Silverstein, M., Winblad, B., Fratiglioni, L. (2006). Mental, physical and social components in leisure activities equally contribute to decrease dementia risk. *Dementia and Geriatric Cognitive Disorders*, 21, 65-73. doi: 10.1159/000089919.
- Katzman, R., Terry, R., DeTeresa, R., Brown, T., Davies, P., Fuld, P.,...Peck, A. (1988). Clinical, pathological, and neurochemical changes in dementia: A subgroup with preserved mental status and numerous neocortical plaques. *Annals of Neurology*, 23, 138-144. doi: 10.1002/ana.410230206.
- Kivipelto, M., Helkala, E. L., Laakso, M. P., Hänninen, T., Hallikainen, M., Alhainen, K.,...Nissien, A. (2001). Midlife vascular risk factors and Alzheimer's disease in later life: longitudinal, population based study. *British Medical Journal*, 322, 1447-1451. doi: 10.1136/bmj.322.7300.1447.
- Lee, D. M., Nazroo, J., O'Connor, D. B., Blake, M., & Pendleton, N. (2015). Sexual health and well-being among older men and women in England: Findings from the English Longitudinal Study of Ageing. *Archives of Sexual Behavior*, 45(1), 133-144. doi: 10.1007/s10508-014-0465-1.
- Lee, D. M., Vanhoutte, B., Nazroo, J., & Pendleton, N. (2016). Sexual Health and Positive Subjective Well-Being in Partnered Older Men and Women. *The Journals of*

- Gerontology, Series B: Psychological Sciences and Social Sciences*, 71(4), 698-710.
doi: 10.1093/geronb/gbw018.
- Marioni, R. E., Proust-Lima, C., Amieva, H., Brayne, C., Matthews, F. E., Dartigues, J. F., & Jacqmin-Gadda, H. (2015). Social activity, cognitive decline and dementia risk: a 20-year prospective cohort study. *BMC Public Health*, 15, 1089. doi: 10.1186/s12889-015-2426-6.
- Melis, M. R., & Argiolas, A. (1995). Dopamine and sexual behavior. *Neuroscience and Biobehavioral Reviews*, 19, 19-38. doi: 10.1016/0149-7634(94)00020-2.
- Regnerus, M., Price, J., & Gordon, D. (2017). Masturbation and partnered sex: Substitutes or complements? *Archives of Sexual Behavior*, 46(7), 2111-2121. doi: 10.1007/s10508-017-0975-8.
- Scarmeas, N., & Stern, Y. (2003). Cognitive reserve and lifestyle. *Journal of Clinical and Experimental Neuropsychology*, 25, 625-633. doi: 10.1076/jcen.25.5.625.14576.
- Stephens, A., Breeze, E., Banks, J., & Nazroo, J. (2013). Cohort profile: The English Longitudinal Study of Ageing. *International Journal of Epidemiology*, 42, 1640-1648. doi: 10.1093/ije/dys168.
- Stern, Y. (2012). Cognitive reserve in ageing and Alzheimer's disease. *Lancet Neurology*, 11(11), 1006-1012. doi:10.1016/S1474-4422(12)70191-6.
- Turvey, C. L., Wallace, R. B., & Herzog, R. (1999). A revised CES-D measure of depressive symptoms and a DSM-based measure of major depressive episodes in the elderly. *International Psychogeriatrics*, 11(2), 139-48. doi: 10.1017/S1041610299005694.
- Valenzuela, M. J., Leon, I., Suo, C., Piamba, D. M., Kochan, N., Brodaty, H., & Sachdev, P. (2013). Cognitive lifestyle in older persons: the population-based Sydney Memory and Ageing Study. *Journal of Alzheimer's Disease*, 36, 87-97. doi: 10.3233/JAD-130143.

- Wang, H. X., Jin, Y., Hendrie, H. C., Liang, C., Yang, L., Cheng, Y.,...Gao, S. (2013). Late life leisure activities and risk of cognitive decline. *Journals of Gerontology. Series A: Biological sciences and medical sciences*, 68, 205-213. doi: 10.1093/gerona/gls153.
- Wilson, R. S., Evans, D. A., Bienias, J. L., Mendes de Leon, C. F., Schneider, J. A., & Bennett, D. A. (2003). Proneness to psychological distress is associated with risk of Alzheimer's disease. *Neurology*, 61, 1479-1485. doi: 10.1212/01.WNL.0000096167.56734.59.
- Wright, H., & Jenks, R. A. (2016). Sex on the brain! Associations between sexual activity and cognitive function in older age. *Age and Ageing*, 45(2), 313-317. doi: 10.1093/ageing/afv197.
- Wright, H., Jenks, R. A., & Demeyere, N. (2017). Frequent Sexual Activity Predicts Specific Cognitive Abilities in Older Adults. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, June 21. doi: 10.1093/geronb/gbx065.

Supplementary Table 3

Summary of multiple regression statistics for each sexual activity predictor variable, adding frequency of i) intercourse, ii) masturbation and iii) kissing/petting/fondling to the model in turn, along with all other covariates. Supplementary Table 3 is split by gender for recall scores

WOMEN (n= 1915)				
<i>Recall / Sexual Intercourse</i>	<i>B</i>	<i>SE B</i>	β	<i>p</i>
Constant	17.66	0.91		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	0.19	0.25	0.03	0.452
Weekly	0.25	0.27	0.04	0.354
Satisfaction (ref: Satisfied)				
Neutral	0.19	0.19	0.03	0.313
Dissatisfied	0.46	0.24	0.05	0.055
Cohabiting (ref: No)	-0.59	0.26	-0.06	0.025
Age (years)	-0.10	0.01	-0.24	< 0.001
Education (ref: Low)				
Intermediate	0.38	0.20	0.06	0.063
Degree/higher	1.18	0.22	0.19	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-0.07	0.26	-0.01	0.785
3 rd	0.02	0.25	0.00	0.923
4 th	0.43	0.22	0.06	0.054
5 th (Wealthiest)	0.36	0.22	0.05	0.105
General Health (ref: Poor)	0.97	0.22	0.12	< 0.001
Physical Activity (re: Low)				
Moderate	0.32	0.18	0.05	0.077
High	0.41	0.23	0.05	0.072
Depression (ref: No)	-0.07	0.22	-0.01	0.739
Loneliness score	-0.16	0.06	-0.07	0.011
<i>Recall / Masturbation</i>	<i>B</i>	<i>SE B</i>	β	<i>p</i>
Constant	17.53	0.86		< 0.001
Masturbation (ref: Never)				
Monthly	0.38	0.19	0.05	0.043
Weekly	1.04	0.38	0.07	0.006
Satisfaction (ref: Satisfied)				
Neutral	0.17	0.19	0.02	0.368
Dissatisfied	0.37	0.24	0.04	0.115
Cohabiting (ref: No)	-0.48	0.27	-0.05	0.073
Age (years)	-0.10	0.01	-0.24	< 0.001
Education (ref: Low)				
Intermediate	0.39	0.20	0.07	0.051
Degree/higher	1.16	0.22	0.19	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-0.04	0.26	-0.01	0.873

3 rd	0.04	0.24	0.01	0.875
4 th	0.44	0.22	0.06	0.044
5 th (Wealthiest)	0.36	0.22	0.05	0.101
General Health (ref: Poor)	0.96	0.22	0.12	< 0.001
Physical Activity (re: Low)				
Moderate	0.34	0.18	0.06	0.056
High	0.41	0.22	0.05	0.071
Depression (ref: No)	-0.09	0.22	-0.01	0.689
Loneliness score	-0.16	0.06	-0.07	0.007
<hr/>				
<i>Recall / Kissing</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	17.54	0.89		< 0.001
Kissing / Petting / Fondling (ref: Never)				
Monthly	0.32	0.28	0.05	0.253
Weekly	0.40	0.26	0.07	0.127
Satisfaction (ref: Satisfied)				
Neutral	0.17	0.19	0.02	0.358
Dissatisfied	0.44	0.24	0.05	0.062
Cohabiting (ref: No)	-0.59	0.26	-0.06	0.025
Age (years)	-0.10	0.01	-0.24	< 0.001
Education (ref: Low)				
Intermediate	0.37	0.20	0.06	0.065
Degree/higher	1.18	0.22	0.19	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-0.06	0.26	-0.01	0.825
3 rd	0.03	0.25	0.00	0.903
4 th	0.43	0.22	0.06	0.050
5 th (Wealthiest)	0.36	0.22	0.05	0.100
General Health (ref: Poor)	0.98	0.22	0.12	< 0.001
Physical Activity (re: Low)				
Moderate	0.33	0.18	0.05	0.072
High	0.41	0.23	0.05	0.071
Depression (ref: No)	-0.05	0.22	-0.01	0.821
Loneliness score	-0.14	0.06	-0.06	0.018
<hr/>				
MEN (n= 2195)				
<hr/>				
<i>Recall / Sexual Intercourse</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	16.59	0.89		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	0.15	0.27	0.01	0.956
Weekly	0.25	0.29	0.04	0.390
Satisfaction (ref: Satisfied)				
Neutral	-0.01	0.23	0.00	0.967
Dissatisfied	0.40	0.20	0.05	0.048
Cohabiting (ref: No)	0.12	0.27	0.01	0.667
Age (years)	-0.11	0.01	-0.26	< 0.001
Education (ref: Low)				

Intermediate	0.47	0.23	0.07	0.043
Degree/higher	1.05	0.23	0.17	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	0.07	0.26	0.01	0.782
3 rd	0.42	0.25	0.05	0.089
4 th	0.44	0.24	0.06	0.061
5 th (Wealthiest)	0.77	0.23	0.11	0.001
General Health (ref: Poor)	0.49	0.21	0.06	0.023
Physical Activity (re: Low)				
Moderate	0.27	0.20	0.04	0.171
High	0.44	0.21	0.06	0.041
Depression (ref: No)	-0.40	0.28	-0.04	0.155
Loneliness score	-0.10	0.07	-0.04	0.132
<i>Recall / Masturbation</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	16.46	0.87		< 0.001
Masturbation (ref: Never)				
Monthly	0.24	0.18	0.04	0.170
Weekly	0.30	0.21	0.04	0.155
Satisfaction (ref: Satisfied)				
Neutral	-0.13	0.23	-0.02	0.569
Dissatisfied	0.29	0.19	0.04	0.134
Cohabiting (ref: No)	0.14	0.27	0.01	0.605
Age (years)	-0.11	0.01	-0.26	< 0.001
Education (ref: Low)				
Intermediate	0.47	0.23	0.07	0.043
Degree/higher	1.04	0.23	0.17	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	0.04	0.26	0.01	0.876
3 rd	0.41	0.25	0.05	0.095
4 th	0.43	0.24	0.06	0.069
5 th (Wealthiest)	0.75	0.23	0.11	0.001
General Health (ref: Poor)	0.48	0.21	0.06	0.024
Physical Activity (re: Low)				
Moderate	0.25	0.20	0.04	0.199
High	0.42	0.21	0.06	0.047
Depression (ref: No)	-0.43	0.28	-0.04	0.127
Loneliness score	-0.10	0.07	-0.04	0.135
<i>Recall / Kissing</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	16.55	0.88		< 0.001
Kissing / Petting / Fondling (ref: Never)				
Monthly	0.15	0.29	0.02	0.610
Weekly	0.26	0.27	0.04	0.341
Satisfaction (ref: Satisfied)				
Neutral	-0.06	0.23	-0.01	0.789
Dissatisfied	0.36	0.19	0.05	0.064

Cohabiting (ref: No)	0.10	0.27	0.01	0.718
Age (years)	-0.11	0.01	-0.27	< 0.001
Education (ref: Low)				
Intermediate	0.48	0.23	0.08	0.039
Degree/higher	1.06	0.23	0.18	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	0.06	0.26	0.01	0.834
3 rd	0.42	0.25	0.05	0.087
4 th	0.43	0.24	0.06	0.065
5 th (Wealthiest)	0.78	0.23	0.11	0.001
General Health (ref: Poor)	0.49	0.21	0.06	0.021
Physical Activity (re: Low)				
Moderate	0.25	0.20	0.04	0.194
High	0.43	0.21	0.06	0.046
Depression (ref: No)	-0.41	0.28	-0.04	0.151
Loneliness score	-0.10	0.07	-0.04	0.162

Note: B = unstandardized beta coefficient; SE = standard error; β = standardised beta coefficient; p = significance value.

Supplementary Table 4

Summary of multiple regression statistics for each sexual activity predictor variable, adding frequency of i) intercourse, ii) masturbation and iii) kissing/petting/fondling to the model in turn, along with all other covariates. Supplementary Table 4 is split by gender for number sequencing scores

WOMEN (n= 1915)				
<i>Number Seq. / Sexual Intercourse</i>	<i>B</i>	<i>SE B</i>	β	<i>p</i>
Constant	561.39	7.19		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	-0.24	2.00	-0.01	0.906
Weekly	0.44	2.17	0.01	0.839
Satisfaction (ref: Satisfied)				
Neutral	-1.27	1.52	-0.02	0.403
Dissatisfied	4.49	1.90	0.06	0.018
Cohabiting (ref: No)	1.97	2.09	0.02	0.348
Age (years)	-0.63	0.09	-0.19	< 0.001
Education (ref: Low)				
Intermediate	5.21	1.60	0.11	0.001
Degree/higher	14.23	1.76	0.29	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.63	2.05	-0.04	0.200
3 rd	2.52	1.95	0.04	0.195
4 th	4.58	1.75	0.08	0.009
5 th (Wealthiest)	5.21	1.75	0.09	0.003
General Health (ref: Poor)	5.73	1.71	0.09	0.001
Physical Activity (re: Low)				
Moderate	1.09	1.43	0.02	0.445
High	1.50	1.80	0.03	0.403
Depression (ref: No)	1.87	1.76	0.03	0.289
Loneliness score	-0.76	0.48	-0.04	0.111
<i>Number Seq. / Masturbation</i>	<i>B</i>	<i>SE B</i>	β	<i>p</i>
Constant	561.19	6.81		< 0.001
Masturbation (ref: Never)				
Monthly	0.23	1.49	0.00	0.877
Weekly	2.03	2.99	0.02	0.498
Satisfaction (ref: Satisfied)				
Neutral	-1.32	1.49	-0.02	0.378
Dissatisfied	4.28	1.87	0.06	0.022
Cohabiting (ref: No)	2.05	2.11	0.03	0.329
Age (years)	-0.63	0.09	-0.19	< 0.001
Education (ref: Low)				
Intermediate	5.24	1.60	0.11	0.001
Degree/higher	14.24	1.75	0.29	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.63	2.05	-0.04	0.199

3 rd	2.52	1.94	0.04	0.194
4 th	4.60	1.75	0.08	0.009
5 th (Wealthiest)	5.25	1.75	0.09	0.003
General Health (ref: Poor)	5.72	1.71	0.09	0.001
Physical Activity (re: Low)				
Moderate	1.10	1.43	0.02	0.440
High	1.49	1.79	0.03	0.406
Depression (ref: No)	1.85	1.76	0.03	0.295
Loneliness score	-0.78	0.48	-0.04	0.102
<hr/>				
<i>Number Seq. / Kissing</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	560.93	7.06		< 0.001
Kissing / Petting / Fondling (ref: Never)				
Monthly	-1.74	2.18	-0.03	0.425
Weekly	0.50	2.07	0.01	0.811
Satisfaction (ref: Satisfied)				
Neutral	-1.11	1.50	-0.02	0.458
Dissatisfied	4.73	1.88	0.07	0.012
Cohabiting (ref: No)	1.81	2.08	0.02	0.386
Age (years)	-0.62	0.09	-0.19	< 0.001
Education (ref: Low)				
Intermediate	5.11	1.60	0.11	0.001
Degree/higher	14.09	1.75	0.28	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.44	2.05	-0.03	0.234
3 rd	2.42	1.94	0.04	0.213
4 th	4.44	1.75	0.08	0.011
5 th (Wealthiest)	5.08	1.75	0.09	0.004
General Health (ref: Poor)	5.81	1.71	0.09	0.001
Physical Activity (re: Low)				
Moderate	1.19	1.43	0.03	0.404
High	1.56	1.79	0.03	0.383
Depression (ref: No)	1.98	1.76	0.03	0.263
Loneliness score	-0.73	0.48	-0.04	0.128
<hr/>				
MEN (n= 2195)				
<hr/>				
<i>Number Seq. / Sexual Intercourse</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	562.89	7.13		< 0.001
Sexual Intercourse (ref: Never)				
Monthly	-4.33	2.14	-0.09	0.043
Weekly	-0.70	2.32	-0.01	0.763
Satisfaction (ref: Satisfied)				
Neutral	-2.64	1.87	-0.04	0.159
Dissatisfied	3.75	1.61	0.06	0.020
Cohabiting (ref: No)	2.30	2.18	0.03	0.219
Age (years)	-0.49	0.09	-0.15	< 0.001
Education (ref: Low)				

Intermediate	7.27	1.87	0.14	< 0.001
Degree/higher	14.58	1.83	0.29	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.60	2.10	-0.04	0.217
3 rd	2.24	1.98	0.03	0.260
4 th	6.66	1.89	0.11	< 0.001
5 th (Wealthiest)	9.03	1.85	0.16	< 0.001
General Health (ref: Poor)	8.56	1.72	0.13	< 0.001
Physical Activity (re: Low)				
Moderate	-2.00	1.57	-0.04	0.201
High	-2.56	1.71	-0.05	0.134
Depression (ref: No)	-1.01	2.27	-0.01	0.657
Loneliness score	-1.65	0.54	-0.08	0.002
<hr/>				
<i>Number Seq. / Masturbation</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	560.72	6.97		< 0.001
Masturbation (ref: Never)				
Monthly	0.70	1.42	0.01	0.620
Weekly	0.82	1.69	0.01	0.629
Satisfaction (ref: Satisfied)				
Neutral	-3.56	1.83	-0.05	0.052
Dissatisfied	3.36	1.56	0.05	0.032
Cohabiting (ref: No)	1.95	2.19	0.02	0.372
Age (years)	-0.49	0.09	-0.15	< 0.001
Education (ref: Low)				
Intermediate	7.29	1.88	0.14	< 0.001
Degree/higher	14.72	1.84	0.29	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.93	2.11	-0.04	0.165
3 rd	2.00	1.99	0.03	0.313
4 th	6.38	1.89	0.11	0.001
5 th (Wealthiest)	8.99	1.86	0.16	< 0.001
General Health (ref: Poor)	8.49	1.73	0.13	< 0.001
Physical Activity (re: Low)				
Moderate	-2.20	1.57	-0.04	0.161
High	-2.75	1.71	-0.05	0.108
Depression (ref: No)	-1.03	2.28	-0.01	0.650
Loneliness score	-1.65	0.54	-0.08	0.002
<hr/>				
<i>Number Seq. / Kissing</i>	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>p</i>
Constant	556.32	7.07		< 0.001
Kissing / Petting / Fondling (ref: Never)				
Monthly	2.82	2.29	0.05	0.218
Weekly	5.05	2.16	0.10	0.020
Satisfaction (ref: Satisfied)				
Neutral	-2.89	1.83	-0.04	0.115
Dissatisfied	4.01	1.56	0.07	0.010

Cohabiting (ref: No)	1.86	2.18	0.02	0.394
Age (years)	-0.49	0.09	-0.14	< 0.001
Education (ref: Low)				
Intermediate	7.51	1.87	0.14	< 0.001
Degree/higher	14.84	1.83	0.30	< 0.001
Wealth quintiles (ref: 1 st = Poorest)				
2 nd	-2.91	2.10	-0.04	0.167
3 rd	2.06	1.98	0.03	0.299
4 th	6.42	1.89	0.11	0.001
5 th (Wealthiest)	9.03	1.85	0.16	< 0.001
General Health (ref: Poor)	8.39	1.72	0.13	< 0.001
Physical Activity (re: Low)				
Moderate	-2.20	1.56	-0.04	0.160
High	-2.70	1.71	-0.05	0.114
Depression (ref: No)	-0.88	2.27	-0.01	0.700
Loneliness score	-1.56	0.54	-0.08	0.004

Note: B = unstandardized beta coefficient; SE = standard error; β = standardised beta coefficient; p = significance value.