Cognitive Impairment, Sexual Activity and Physical Tenderness in Community-Dwelling Older Adults: A Cross-Sectional Exploration

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Abstract

Background: The ability to engage in sexual activity and better cognitive functioning are both associated with better health. However, the association between cognitive functioning and sexual activity is understudied. Objective: To examine the association between cognitive functioning with sexual activity and physical tenderness among community-dwelling older adults. Methods: From the Rotterdam Study, cognitive impairment and sexual activity were assessed in 4,201 community-dwelling, 60+ year olds between 2008 and 2014 in the Netherlands. Mild cognitive impairment (MCI) was based upon subjective complaints related to age and education-adjusted test scores. Mini-Mental State Examination (MMSE) impairment was defined by a score of <26. Sexual activity and physical tenderness (e.g., fondling or kissing) in the last 6 months were assessed at an interview. Analyses were stratified by gender and partner status, with prevalence rates for the “no impairment” categories weighted based on age from the cognitive impairment categories. Inter-rater reliability was examined utilising 74 cohabiting couples of opposite gender. Results: It was found that 14\% were categorised as having cognitive impairment, and <1\% as dementia (excluded from subsequent analyses). There was strong evidence that the odds of engaging in physical tenderness (observed through MMSE <26, OR 2.14, 95\% CI 1.32–3.48, \( p = 0.002 \)) and sexual activity (MCI, OR 2.36, 95\% CI 1.35–4.12, \( p = 0.003 \)) among partnered females with no impairment was twice that observed among cognitively impaired partnered females. There was weak evidence that the odds of engaging in physical tenderness (MMSE <26, OR 1.59, 95\% CI 1.04–2.42, \( p = 0.03 \)) and sexual activity (MMSE < 26, OR 1.51, 95\% CI 1.02–2.24, \( p = 0.04 \)) among partnered males with no impairment was 50\% greater than observed among cognitively impaired partnered males. The associations between cognitive functioning and physical tenderness continued to remain after adjustment for physical function, diabetes, cardiovascular disease and cancer. There was...
Sexual activity contributes to quality of life and can be regarded as an essential element of human well-being and happiness [1–3]. The World Health Organization views sexual health as “a state of physical, emotional, mental and social well-being related to sexuality; not merely the absence of disease, dysfunction or infirmity” with sexuality as “a central aspect of being human throughout life” [4]. Hence, sexual activity is of interest beyond reproductive years and older adults are being increasingly incorporated in sexual activity research. Prior research among older adults has identified that engaging in sexual activity is generally associated with younger age [5, 6], male gender [5, 7], marriage or cohabitation [5, 7], greater social support [8] and socioeconomic position [5, 7, 9, 10], engagement in physical and social activities [5, 8], healthier behaviours [5, 8], and absence of physical and mental health conditions for both themselves and their partner [5–9, 11]. A previous limitation of research on sexual activity has been the concentration upon sexual dysfunction [12] or sexual intercourse [1, 7, 9, 11]; however, gradually the concept of sexual activity research has expanded to include aspects such as touching, holding, or close companionship expressed between individuals [1, 5, 13–15]. When assessing sexual activity among older adults, it is critical to acknowledge the importance of the broader aspects, as affection has been reported as more important to older married adults than sexual activity [16].

Recently, we explored sexual activity and physical tenderness among 2,374 community-dwelling older adults, including confirmation of inter-rater reliability through 304 opposite-sex couples [5]. However, we excluded individuals with cognitive impairment or dementia, which is common practice among older adult samples due to difficulties surrounding reliability of self-report questionnaires and potential concerns regarding confounding and effect modification. Greater cognitive function has been associated with better physical and psychological health, and greater quality of life among older adults [17]. However, there is limited research examining the association between cognitive functioning and sexual activity in the ageing population, particularly within non-patient settings [17, 18]. A systematic review published in 2014 identified only 8 publications from 7 cohorts, of which 5 recruited dementia patients and/or their partners and only 2 recruited older persons through other sources, specifically through general practitioners or community mass mailing [18]. These cross-sectional comparisons demonstrated an “indication that sexual activity in later life is associated with better overall cognitive functioning...The few studies found are limited, methodologically weak, and inconclusive” [18]. Since this systematic review, we have identified 2 further studies assessing the association between cognitive functioning and sexual activity among older adults [17, 19, 20].

This paper aims to contribute to our understanding of the association between cognitive functioning and sexual activity (assessed as sexual activity and physical tenderness) through the assessment of a large sample of community-dwelling, older adults aged 60 years or older. First, we provide cross-sectional prevalence of sexual activity and physical tenderness among cognitively impaired, community-dwelling older adults. Second, we compare the prevalence of sexual activity and physical tenderness between impaired and non-impaired older adults. Third, we assess the reliability of self-reported sexual activity within a sub-sample of cognitively impaired older adults and their non-cognitively impaired cohabitating partner of the opposite gender. Results were stratified by gender and partner status due to their differential effects upon sexual availability [1, 5, 21].

Methods

Study Sample

The Rotterdam Study is a population-based cohort designed to examine the onset of disease in older adults [22]. In 1990, 7,983 residents aged 55+ years from the district of Ommoord were recruited to the Rotterdam Study, followed by a second recruitment wave in 2000 of 3,011 residents aged 55+ years and a third recruitment wave in 2006 of 3,932 residents aged 45+ years. As our study population was recruited from 1 suburb in a country with relatively low social inequity [23], it can be considered homogenous, particularly in terms of socioeconomic position. While the original recruitment cohort had prominently Dutch heritage, the district had changed and a range of ethnic backgrounds prominent in the...
Cognitive Impairment, Sex and Tenderness

Participants were assessed by trained interviewers in face-to-face interviews either at home or at the Ommoord district research centre and were asked “Have you been sexually active in the past 6 months?” with response options “yes,” “no” or “I do not know.” If the response was “no,” participants were subsequently asked “Have you experienced other forms of physical tenderness in the last 6 months (e.g., fondling or kissing)?”

Mild Cognitive Impairment

Mild Cognitive Impairment (MCI) was defined as the presence of subjective and objective cognitive complaints in the absence of dementia for Rotterdam Study participants aged 60 years or more using official criteria, and has been described in detail elsewhere [24]. Subjective cognitive complaints were examined by answering yes to at least 1 question evaluating memory (3 items: difficulty remembering, forgetting what I had planned to do, and difficulty finding words) or everyday functioning (3 items: difficulty managing finances, problems using a telephone, and difficulty getting dressed) [24]. Objective cognitive impairment was derived from a cognitive test battery comprising letter-digit substitution task, Stroop test, verbal fluency test and 15-word verbal learning test based on Rey’s recall of words. To obtain more robust measures, compound scores for various cognitive domains including memory function, information-processing speed and executive function were constructed [24]. Compound scores for memory, information processing speed and executive function were calculated using Z-scores, and a person was classified as cognitively impaired if they scored below 1.5 SD of the age and education adjusted means of the study population. For MCI subtypes, the distinction by Roberts and Knopman et al. [25] was followed. As described by de Bruijn et al. [24], “Amnestic MCI was defined as persons with MCI who had an impaired test score on memory function (irrespective of other domains). Non-amnestic MCI was defined as persons with MCI having normal memory function, but an impaired test score on executive function or information-processing speed.”

Cognitive Impairment Based on Mini Mental State Examination

Cognitive impairment was defined as a Mini Mental State Examination (MMSE) score of less than 26 (< 26). For the Rotterdam Study, an MMSE score < 26 has been previously utilised to distinguish cognitive impairment, and has been utilised as an exclusion criteria when completing self-reported questionnaires [5, 21, 26]. The MMSE is a validated, self-reported instrument that measures general cognitive function. It consists of 30 questions examining orientation, registration (repeating named prompts), attention and calculation, recall, language and ability to follow simple commands.

Dementia

Participants were screened for dementia at baseline and subsequent Rotterdam Study centre visits with the MMSE and the Geriatric Mental Schedule [30, 32] organic level [27]. Those with an MMSE < 26 or Geriatric Mental Schedule score > 0 underwent further examination and informant interview, including the Cambridge Examination for Mental Disorders of the Elderly. In addition, all participants underwent routine cognitive assessment and the entire cohort were continuously monitored for dementia through electronic linkage of the study database with medical records from general practitioners and the regional institute for outpatient mental health care. Available information on cognitive testing and clinical neuroimaging was used when required for diagnosis of dementia subtype. A consensus panel led by a consultant neurologist established the final diagnosis according to standard criteria for dementia (Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised), Alzheimer’s Disease (National Institute of Neurological and Communicative Diseases and Stroke/Alzheimer’s Disease and Related Disorders Association) and vascular dementia (National Institute of Neurological Disorders and Stroke and Association Internationale pour la Recherche et l’Enseignement en Neurosciences).

Potential Health Confounders

Activities of daily living [28, 29] (ADL), diabetes, cardiovascular disease (CVD) and cancer were selected a priori selected [30] as potential confounders for the relation between cognitive functioning and sexual activity. Diabetes, CVD (stroke, heart failure and coronary heart disease) [31] and cancer are 3 of the 4 most common chronic disease domains [32]. Diabetes mellitus was defined as self-reported through questionnaire and/or a serum fasting glucose
measurement of ≥7.0 mmol/L using laboratory data derived from blood sampling performed at the research centre. For CVD and cancer, incident data was obtained through continuously monitoring day-to-day medical records and coded with agreement from 2 research physicians [31, 33] and was available up to April 1, 2010.

**Stratification and Weighting**

Results were stratified by gender (male or female) and partner status (partnered or unpartnered) due to their differential effects upon sexual availability [1, 5, 21] and cognitive impairment. Partner status was determined by asking (1) “What is your marital status?” with response options “never been married,” “married/cohabiting,” “widowed” and “divorced.” Those who did not answer “married/cohabiting” were asked (2) “Do you currently have a partner?” with response options “yes, a partner with whom I live,” “yes, a partner with whom I do not live” and “no, I have no partner.” Those who answered “married/cohabiting,” “yes, a partner with whom I live,” or “yes, a partner with whom I do not live” were considered “partnered,” while those who answered “no, I have no partner” to the second question were considered “unpartnered.”

Increasing age is a strong predictor of reduced engagement in sexual activity [5, 6] and increased cognitive impairment. To provide comparative sexual activity and physical tenderness rates by cognitive status, the “no impairment” groups were weighted based upon 5-year age bands from the “cognitive impairment” groups after partner and gender stratification using the `fweight` command in Stata. There were eight 5-year age bands starting at 60 < 65, and ending with 100 ≤ 106.

**Statistical Analysis**

First, we categorised participants into cognitive impairment categories of “dementia,” “MCI” or “no MCI,” and “MMSE <26” or “MMSE ≥26,” and examined demographic differences between categories. Second, we assessed the prevalence of sexual activity and physical tenderness in the previous 6 months stratified by cognitive impairment category, gender and partner status groups.

Through sensitivity analyses we explored the second aim by adjustment of potential health confounders, by further categorisation of amnestic and non-amnestic sub-groups for MCI and by assessment in a sub-sample of couples who cohabited at the same address, were of the opposite gender and 1 partner was categorised as MCI. We had no reliable information on same-sex couples.

**Results**

**Cognitive Impairment Status**

One in seven participants was categorised as having cognitive impairment or dementia, Table 1. Slightly more participants were categorised as having cognitive impairment through the MMSE (9.33%) than the MCI (7.05%), and less than 1% were categorised as having dementia, Table 1. As expected, participants categorised as “no impairment” were more likely to be younger, be partnered, be highly educated, have greater physical functioning, have no diabetes and have no cardiovascular disease than participants with cognitive impairment, Table 2. Cognitive impairment categorisation was distinctly different between MMSE and MCI (chi² = 198, $p < 0.001$), Table 1. There were 158 participants with a missing MMSE score, who had other measures to categorise them as having no MCI. Participants with dementia were more likely to be older than participants with no impairment and participants with MCI. The number of participants categorised as having dementia ($n = 28$) was too small for further exploration and presented demographic differences should be interpreted with caution.

**Cognitive Impairment Status, Sexual Activity and Physical Tenderness**

In general, being categorised as having cognitive impairment was associated with lower engagement in sexual activity and physical tenderness; however, the strength of the association varied by cognitive impairment mea-

### Table 1. Categorisation of cognitive impairment and dementia

| MMSE cognitive impairment | none (MMSE ≥26) | impairment (MMSE <26) | dementia | missing | total |
|---------------------------|-----------------|----------------------|----------|---------|-------|
| MCI                       | 3,425           | 294                  | 0        | 158     | 3,877 |
| No MCI                    | 198             | 98                   | 0        | 0       | 296   |
| Dementia                  | 0               | 0                    | 28       | 0       | 28    |
| Total                     | 3,623           | 392                  | 28       | 158     | 4,201 |

MCI, mild cognitive impairment; MMSE, mini mental state examination.

Cross-sectional binary logistic regression analyses were performed using Stata version 14. We defined statistically significance as a p value of <0.05 and results are interpreted in accordance with Wasserstein and Lazar [34].

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Table 2. Demographic characteristics by cognitive functioning categorisation

|                  | MCI assessment | Cognitive impairment assessment through MMSE | Dementia |
|------------------|---------------|---------------------------------------------|-----------|
|                  | No MCI | MCI | p value | no impairment (MMSE ≥26) | impairment (MMSE <26) | p value | dementia | p value (vs. "no MCI") | p value (vs. "MCI") | p value (vs.MMSE ≥26) | p value (vs.MMSE <26) |
| % (n)            | 92.29 (3,877) | 7.05 (296) | – | 89.61 (3,623) | 9.70 (392) | – | 0.67–0.69 (28) | – | – | – | – |
| Age, years       | 72.04±7.48 | 74.28±7.62 | <0.001 | 71.61±7.30 | 77.74±7.13 | <0.001 | 78.02±7.04 | <0.001 | 0.01 | <0.001 | 0.8 |
| Gender, %        |         |         |         |         |         |         |         |         |         |         |         |
| Female           | 58.06 | 52.36 | 0.06 | 57.85 | 54.59 | 0.2 | 42.86 | 0.1 | 0.3 | 0.1 | 0.2 |
| Male             | 41.94 | 47.64 |         | 42.15 | 45.41 |         | 57.14 |         |         |         |         |
| Education, %     |         |         |         |         |         |         |         |         |         |         |         |
| Low              | 17.43 | 26.89 | <0.001 | 15.57 | 37.76 | <0.001 | 35.71 | 0.02 | 0.3 | 0.005 | 0.8 |
| Intermediate     | 64.03 | 57.59 |         | 64.49 | 55.99 |         | 42.86 |         |         |         |         |
| High             | 18.54 | 15.52 |         | 19.94 | 6.25 |         | 21.43 |         |         |         |         |
| Partner Status, %|         |         |         |         |         |         |         |         |         |         |         |
| Partnered        | 71.32 | 65.54 | 0.04 | 72.09 | 60.20 | <0.001 | 71.43 | 1.0 | 0.5 | 0.9 | 0.2 |
| Unpartnered      | 28.68 | 34.46 |         | 27.91 | 39.80 |         | 28.57 |         |         |         |         |
| Activities of daily living, units | 0.44±0.48 | 0.68±0.66 | <0.001 | 0.43±0.46 | 0.70±0.67 | <0.001 | 0.71±0.77 | 0.01 | 0.7 | 0.005 | 1.0 |
| Diabetes, %      |         |         |         |         |         |         |         |         |         |         |         |
| Prevalent        | 14.92 | 21.53 | 0.003 | 14.71 | 21.58 | <0.001 | 16.67 | 0.8 | 0.6 | 0.8 | 0.6 |
| Absent           | 85.08 | 78.47 |         | 85.29 | 78.42 |         | 83.33 |         |         |         |         |
| Cardiovascular disease, % |         |         |         |         |         |         |         |         |         |         |         |
| Prevalent        | 11.30 | 20.95 | <0.001 | 10.65 | 24.49 | <0.001 | 17.86 | 0.3 | 0.7 | 0.2 | 0.4 |
| Absent           | 88.70 | 79.05 |         | 89.35 | 75.51 |         | 82.14 |         |         |         |         |
| Cancer, %        |         |         |         |         |         |         |         |         |         |         |         |
| Prevalent        | 27.82 | 28.13 | 0.9 | 27.73 | 28.95 | 0.6 | 34.78 | 0.5 | 0.5 | 0.5 | 0.6 |
| Absent           | 72.18 | 71.88 |         | 72.27 | 71.05 |         | 65.22 |         |         |         |         |

MCI, mild cognitive impairment; MMSE, mini mental state examination.
Measurement (Fig. 1, 2). Low sexual activity and physical tenderness engagement among unpartnered participants restricted further exploration. When categorised by MCI, there was strong evidence that the odds of engaging in sexual activity among partnered females with no impairment was at least twice that observed among partnered females with MCI (OR 2.36, 95% CI 1.35–4.12, p = 0.003, Appendix 3). However, there was no evidence of an association between MCI impairment and physical tenderness or among males for sexual activity (p > 0.05, results not shown).

When MMSE was assessed as a continuous measure (mean 27.77 ± 2.34 SD), each unit increase was associated with a 0.60% higher likelihood of engaging in sexual activity (p = 0.004) and a 0.70% higher likelihood of engaging in physical tenderness (p < 0.001), after adjustment for age, gender and partner status. When categorised by the MMSE cut-off of 26, there was weak evidence that the odds of engaging in sexual activity (OR 1.51, 95% CI 1.02–2.24, p = 0.04, Appendix 3) and physical tenderness (OR 1.59, 95% CI 1.04–2.42, p = 0.03) was at least 50% greater among partnered males with no impairment than that observed among partnered males with impairment. There was also strong evidence that the odds of engaging in physical tenderness among partnered females with no impairment based on MMSE was at least twice that observed among partnered females with MMSE impairment (OR 2.14, 95% CI 1.32–3.48, p = 0.002).

Adjustment for Potential Health Confounders
After adjustment for ADLs, prevalent diabetes, CVD and cancer, the association between MMSE categorisation and physical tenderness continued to remain, and the magnitude of the association increased for males (Appendix 3). After adjustment, the magnitudes reduced and there was no longer evidence of an association between sexual activity with MCI categorisation for females and sexual activity with MMSE categorisation for males.

Amnestic and Non-Amnestic Sub-Groups of MCI
When compared to no impairment, there was no clear evidence of a difference compared to no MCI between with-amnestic (n = 104) and non-amnestic (n = 192) sub-groups of MCI in terms of sexual activity (adjusted for age, sex and partner status: p = 0.06 and p = 0.6, respectively) or physical tenderness (p = 0.8, p = 0.09). When amnestic was compared to non-amnestic, there was no evidence of a difference in terms of sexual activity...
Cognitive Impairment, Sex and Tenderness

In our study population, 1 in 7 community-dwelling older adults had cognitive impairment or dementia. Less than 1% were categorised as having dementia and were excluded from subsequent analyses. In general, cognitive impairment was associated with lower engagement in sexual activity and physical tenderness; however, the strength of the association varied by cognitive impairment measurement. For partnered older adults, there was strong evidence that the odds of engaging in physical tenderness (observed through MMSE < 26) and sexual activity (MCI) among females with no impairment were at least twice that observed among cognitively impaired females. There was weak evidence that the odds of engaging in physical tenderness (MMSE < 26) and sexual activity (MMSE < 26) among males with no impairment were at least 50% greater than that observed among cognitively impaired males. After adjustment for ADLs, diabetes, CVD and cancer, the association between no impairment and greater sexual activity no longer remained. There were no differences between amnestic and non-amnestic sub-groups of MCI. There was agreement for both sexual activity and physical tenderness between the coupled sub-sample that had 1 partner categorised as having MCI.

Our cognition and sexual activity findings are in line with the findings of 3 comparable cross-sectional studies among older adults, particularly as we also observed that the strength and magnitude of the association with sexual activity varied by cognitive impairment measurement. Among 335 Italians aged over 65 years, who were recruited through general practitioners, sexual activity questions were answered between 1992 and 1995 [35]. While there was limited evidence that self-reported cognitive functioning examined through 5 questions (ability to concentrate, feelings of confusion and any mnemonic difficulties) was associated with sexual interest or sexual activity, there was moderate evidence that MMSE was associated for sexual interest (OR 2.13, \( p = 0.01 \)) and sexual activity (OR 2.32, \( p = 0.01 \)) [35]. The 335 person sample had greater MMSE cognitive impairment (mean score 25.3 ± 4.1 [35]) than our sample, with 56% [36] having an MMSE ≤26 compared to 20%.
in our sample (however, we utilised MMSE <26 and reported 10%). Among the 335 older adults with MMSE ≤26, 12.7% reported sexual interest and 4.6% reported sexual activity, which are much lower than our comparable unadjusted sexual activity prevalence rate of 26.72% – possible due to the generational differences [20] between samples. While further exploration was undertaken [35, 36], the sample size limited conclusions, especially by age and gender stratification. Among 662 older community-dwelling menopausal American women aged 57–90 years, sexual satisfaction was associated with subjective attitudes towards aging and emotional functioning, rather than cognitive status [37]. However, the 662 sampled studies were presented as an abstract and the association between sexual satisfaction and cognitive status in the absence of additional adjustments was not presented; hence, these results are not comparable to our study. Among 6,833 representative, community-dwelling English aged 50–89, questions related to sexual activity was asked as part of the English Longitudinal Study of Ageing [17]. Within English Longitudinal Study of Ageing, sexual activity was defined as an activity that included “intercourse, masturbation, petting or fondling” [17], and hence could be considered a measure in-between our “sexual activity” and “physical tenderness” questions. Among the 3,060 older men, there was strong evidence of an association between sexual activity and both number sequencing and recall (mean difference after adjustment for age, education and wealth; sequencing: 4.6, p < 0.001, recall: 0.7, p < 0.001). However, among the 3,773 women there was strong evidence of an association between sexual activity and recall only (0.3, p < 0.002; sequencing 1.4, p = 0.1). While our findings presented in this paper are similar, the 6,833 sample included much younger adults (mean 66 years) and examined cognitive tests continuously rather than categorising cognitive impairment, which limits comparability. Among 73 community-dwelling English aged 50–83, there was weak to moderate evidence that weekly engagement in sexual activity (compared to never) was associated with cognitive functioning examined through fluency (B = 1.63 ± 0.65 SE, p = 0.01) and the validated cognitive questionnaire Addenbrooke’s Cognitive Examination-III (ACE-III; B = −4.39 ± 2.07 SE, p = 0.04), after adjustment for age, gender, education and cardiovascular health [22]. A measurement of sexual frequency was certainly a strength of this 73 sampled study, especially because a dose-response association with cognitive domains was observed. However, there was no evidence of a difference between engaging weekly or monthly in sexual activity, and no evidence of the association when cognitive functioning was examined through visuospatial, attention, memory or language. The authors noted that a larger sample size may be required to detect smaller differences, which may also be relevant to our MCI findings, as they were in the same direction but generally of lower in magnitude compared to the MMSE <26 categorisation. Additionally, a larger sample size may be required to assess MCI subtypes. Despite differential underlying aetiology, pathology, clinical presentation and outcomes [25], there was no difference between the MCI subtypes of amnestic (impaired memory function) and non-amnestic (impaired executive function or information-processing speed) with regard to sexual activity in our sample. There are a range of cognitive measures from validated cognitive questionnaires, which can be used for diagnosis (for example MCI) to those which are commonly used for screening purposes (e.g., MMSE, number sequencing and fluency), and these are likely testing different concepts of cognitive functioning. Furthermore, some cognitive questionnaires are developed to be sensitive to cognitive decline (e.g., MMSE), rather than cognitive variation. In relation to sexual activity, the current literature generally reflects that the cognitive impairment measures used for diagnosis have a weaker and lower magnitude of association with sexual activity when compared to the cognitive impairment measures used for screening purposes.

Co-morbidity may account for some of the association between reduced sexual activity and reduced cognitive function. In our study sample, we observed that, as expected, older adults with no cognitive impairment were more likely to have greater physical functioning and lower prevalence of chronic disease. Prior research among older adults has identified that engaging in sexual activity is generally associated with the absence of physical and mental health conditions for both themselves and their partners [5–9, 11]. Hence, our finding that the association between cognitive impairment and sexual activity no longer remained after adjustment for ADLs, diabetes, CVD and cancer is somewhat expected. It is unclear whether 2 [35–37] of the comparable cross-sectional studies adjusted analyses, although a range of physical health, psychological health, social function, life satisfaction, attitude and resilience aspects were mentioned between the 2 studies. Fully adjusted models did not affect the findings from the study of 6,833 English older adults [17]. Their first model adjusted for age, education and wealth (findings summarised above), while the final model further...
adjusted for physical activity, cohabiting and self-rated health, depression, quality of life and loneliness. However, their sexual activity question is not directly comparable as it could be considered a measure in-between our “sexual activity” and “physical tenderness” questions. Our finding that no impairment was associated with physical tenderness after co-morbidity adjustment illustrates that cognitive functioning may be a potential barrier to maintaining or instigating intimate relationships.

As the current evidence examining sexual activity and cognitive impairment is cross-sectional, we can only speculate upon the direction of effect at this time. There are theoretical explanations for the direction of effect in both directions, and it is possible that the association is bi-directional. Engaging in sexual activity is generally associated with better psychological and physical health [5], and improved cognition or prolonged cognitive function may be one benefit. A range of hormones are released during sexual activity and orgasm, including dopamine, which is associated with motor function [38]. Additionally, variations in sex-related hormones, such as higher levels of testosterone, lower estradiol, higher follicle-stimulating hormone, higher luteinising hormone, higher dehydroepiandrosterone sulfate and higher prolactin are associated with poorer cognition [39].

Alternatively, structural processes can deteriorate as part of cognitive impairment and may impact sexual activity.

Sexual problems associated with dementia are well established, with neuronal loss theorised to proceed altered sexual activity [40]. More current literature also discuss the cognitive and decision-making processes involved in sexual behaviour: “In the process of sexual functioning and reaching an orgasm, there are several identified moments in sexual behavior at which a decision is or can be made. The decision-making process involves aspects of judgment, consent, sense of self, sense of other, and abstract thinking, all of which require intact memory and executive functioning” [18]. As examples, sexual arousal involves cortical functions including the limbic and paralimbic cortices [41], and these structures may be impacted through cognitive impairment [18]. One way in which these structural and cognitive processes may lead to the variance in sexual behaviour is through a decline in sexual interest. Cross-sectional comparisons among community-dwelling elderly identified that higher cognitive functioning was associated with perceiving sexuality as important, remaining a need for intimacy when getting older, and evaluating sexual life as pleasant [42]. Hence, future research should not only incorporate broader aspects as affection but also incorporate aspects of sexual interest.

**Strengths and Limitations**

The main limitation of this study is the low number of participants with dementia, which is likely to be an under-representation due to the interviewers being more likely to ask sexual activity questions to participants without dementia. Additionally we identified several common limitations of sexual activity research that were also present in this study. First, within the unpartnered older adults, there was low sexual activity engagement and a small sample size for men [5], and hence, we were likely underpowered to examine differences in unpartnered participants. While this limited our exploration among unpartnered older adults, there is no reason that the relation between cognitive functioning and sexual activity would be different by partner or/and gender status. If we had a larger sample of unpartnered older adults, we hypothesize that the relation between cognitive functioning and sexual activity would be reflective of the relation within the partnered cohort. Second, there were very few older adults with dementia to examine specific associations. Third, sexual orientation (homosexual, heterosexual or bisexual) is rarely considered and was not assessed in our or the other studies. Fourth, “sexual activity” was a single question and left open for interpretation [5]. It is possible that the individual in the different groups (as defined by stratification for age, gender or cognitive impairment status) interpret the questions differently, leading to different understanding and some misclassification. It is only recently that research has incorporated broader definitions of sexual activity as any sexually arousing activities [43]. In this study, we provided the examples of fondling and kissing for physical tenderness. Nevertheless, because, inevitably, each participant interpreted the question a wide range of sexual behaviours, including solo masturbation (which is more common for older men than older women [14, 44]), could have been overlooked. Future research would benefit from the frequency of sexual behaviour, additional clarification of activities such as solo masturbation, and additional questions pertaining to sexual opinions, feelings and function. Finally, this study design is cross-sectional and further longitudinal research is required.

While having 2 measures of cognitive impairment is a strength of this study, the MMSE may have floor and ceil-
ing effects within community samples that should be con-
considered when interpreting data from longitudinal studies
of cognitive decline [45]. This paper overcomes several
limitations of sexual behaviour research as we explicitly
asked about physical tenderness (not just sexual activity)
in older age groups though assessment in one of the larg-
est samples of older adults [9, 20, 46–48] who were not
recruited explicitly to talk about their sexuality nor were
limited by partner status or sexual orientation. Addition-
al strengths include the recent interval (of 6 months rath-
er than one year [13, 49]), and the assessment of MCI
[24]. Our results of an association between cognitive im-
pairment and sexual behaviour are likely generalisable to
community-dwelling older adults in Westernized cul-
tures. As the Netherlands is known for being open-mind-
ed on sexual matters [50], particularly in regards to ho-
mosexuality, and has relatively low social inequity [23],
prevalence rates may differ between countries with differ-
cultural norms.

Knowledge Translation

Our findings contribute to the understanding of sex-
ual activity in later life, and respond to the claim by
older adults that their lives can be improved by normal-
ising sexual activity and desire [51]. Here we illustrate
that reductions in cognitive function form a potential
barrier to maintaining or instigating intimate relation-
ships.

Sexuality is an important aspect of active aging and is
increasingly important to older adults [52, 53]. The ste-
reotyping of older adults as not interested or not engag-
ing in sexual activity has direct implications for the
physical health and well-being of older adults. Undiag-
nosed or untreated sexual problems can lead to depres-
sion, anxiety, social withdrawal and other mental health
issues [54]. Addressing sexual activity among older
adults and even having open discussions can contribute
to maintaining and improving quality of life and reduc-
ning misconceptions. We encourage health care profes-
sionals to proactively address sexuality and extend
knowledge about safe sex and sexual functions to older
adults.

Conclusion

This is the first study to present prevalence rates for
either sexual activity or physical tenderness among older
community-dwelling adults who are cognitively im-
paired, and the first study to examine inter-rater reliabil-
ity within a coupled sub-sample who had one partner
with cognitive impairment. Our findings are aligned with
prior research, and highlights that greater cognitive im-
pairment is associated with less engagement in sexual ac-
tivity and physical tenderness. Additionally, we illustrat-
ed that co-morbidity may explain the reductions in sexu-
al activity but not physical tenderness for cognitive
impaired older adults. As the strength and magnitude of
the association with sexual behaviour varies by cognitive
impairment measurement, future research requires
thought as to the sensitivity of such cognitive measures.
Additionally, there are implications for sexual behaviour
research in community samples, as exclusion criteria
based on cognitive functioning may provide different
outcomes. Sexuality is an important aspect of active aging
and our findings illustrate a potential barrier to maintain-
ning or instigating intimate relationships as we age. As
findings are cross-sectional, longitudinal analysis is re-
quired to explore the direction of effect.

Acknowledgements

We would like to thank Frank van Rooij, Renée de Bruijn,
Annemarie Luik, Maarten Leening, and Hoyan Wen for their
assistance with data preparation.

Author Contributions

R.F.-P. takes responsibility for the analysis design, the integrity
of the data, the accuracy of the data analysis and the critical inter-
pretation of the data. H.T. supervised data collection on sexual
activity and physical tenderness, and contributed to interpretation
of the results. All authors contributed to the final version of the
paper and have read, as well as, approved of the final manuscript.

Financial Disclosures

The Rotterdam Study is supported by Erasmus Medical Centre
and Erasmus University Rotterdam, the Netherlands Organization
for Scientific Research (NWO), the Netherlands Organization for
Health Research and Development (ZonMw), the Netherlands Ge-
nomics Initiative, the Ministry of Education, Culture and Science,
the Ministry of Health, Welfare and Sports and the European
Commission (DG XII). RFP, GDCL, AH and HT are affiliated with
Erasmus Medical Centre. RFP is also affiliated with Monash Uni-
versity. RFP is supported by a NHMRC ECR Fellowship (1053666).
The authors declare no further conflicts of interest. The data col-
lection, analysis and interpretation of data; the writing of the man-
uscript; and the decision to submit the manuscript for publication
were solely at the discretion of the Erasmus researchers, indepen-
dent of the funders.
Appendix 1

Flowchart

Attended data collection between 2008 and 2014, aged 60 or more years (n = 5,943) 

Ineligible
Two trained interviewers felt uncomfortable asking the sexual activity and physical tenderness questions (n = 615)
Not asked the sexual activity or physical tenderness questions (n = 1,042)
Do not have cognitive impairment information (n = 18)

Eligible (n = 4,291)

Excluded
Answered "I do not know" to both sexual activity and physical tenderness questions (n = 40)
Incomplete partner status (n = 5)
Lived in a nursing home (n = 12)
Did not provide consent for data linkage (n = 80)

Included (n = 4,136)

Appendix 2

Association between the act of being asked sexual activity questions by trained interviewers and demographic and health indicators

|                          | Asked          | Not asked       | Univariate p value | Age adjusted p value | Gender adjusted p value |
|--------------------------|----------------|-----------------|--------------------|----------------------|-------------------------|
| n (%)                    | 4,316 (82.81)  | 896 (17.19)     | –                  | –                    | –                       |
| Age, years               | 72.31±7.53     | 71.99±7.70      | 0.3                | –                    | 0.3                     |
| Gender, %                |                |                 |                    |                      |                         |
| Female                   | 42.24          | 42.41           | 0.9                | 1.0                  | –                       |
| Male                     | 57.76          | 57.59           |                    |                      |                         |
| Education, %             |                |                 |                    |                      |                         |
| Low                      | 18.45          | 18.22           | 0.7                | 1.0                  | 0.9                     |
| Intermediate             | 63.51          | 62.53           |                    |                      |                         |
| High                     | 18.04          | 19.25           |                    |                      |                         |
| Partner status, %        |                |                 |                    |                      |                         |
| Partnered                | 29.34          | 31.81           | 0.1                | 0.06                 | 0.1                     |
| Unpartnered              | 70.66          | 68.19           |                    |                      |                         |
| Living situation, %      |                |                 |                    |                      |                         |
| Independent              | 90.5           | 88.55           | <0.001             | 0.04                 | 0.07                    |
| Service flat             | 9.25           | 9.88            |                    |                      |                         |
| Nursing home             | 0.26           | 1.57b           |                    |                      |                         |
| Mini Mental State Examination, units | 27.76±2.35 | 27.69±2.29 | 0.4 | 0.2 | 0.5 |
| Mini Mental State Examination impairment, % |                |                  |                    |                      |                         |
| Prevalent                | 9.94           | 11.11           | 0.3                | 0.1                  | 0.3                     |
| Absent                   | 90.06          | 88.89           |                    |                      |                         |
| Mild cognitive impairment, % |                |                  |                    |                      |                         |
| Prevalent                | 7.05           | 5.64            | 0.1                | 0.2                  | 0.1                     |
| Absent                   | 92.95          | 94.36           |                    |                      |                         |
| Dementia, %              |                |                 |                    |                      |                         |
| Prevalent                | 0.74           | 1.7             | 0.007              | 0.008                | 0.008                   |
| Absent                   | 99.26          | 98.3            |                    |                      |                         |
|                          | Asked          | Not asked      | Univariate p value | Age adjusted p value | Gender adjusted p value |
|--------------------------|----------------|----------------|--------------------|----------------------|-------------------------|
| Activities of daily living, units | 0.47±0.51      | 0.57±0.6       | <0.001             | <0.001               | <0.001                  |
| Diabetes, %              |                |                |                    |                      |                         |
| Prevalent                | 15.36          | 13.85          | 0.3                | 0.4                  | 0.3                     |
| Absent                   | 84.64          | 86.15          |                    |                      |                         |
| Cardiovascular disease, %|                |                |                    |                      |                         |
| Prevalent                | 12.00          | 14.06          | 0.09               | 0.049                | 0.09                    |
| Absent                   | 88.00          | 85.94          |                    |                      |                         |
| Cancer, %                |                |                |                    |                      |                         |
| Prevalent                | 27.93          | 27.93          | 1.0                | 0.8                  | 0.9                     |
| Absent                   | 72.07          | 72.07          |                    |                      |                         |

* Participants were excluded from this table as they did not provide consent for data linkage (n = 24).  
  These participants are excluded from this study sample due to living in a nursing home, regardless of sexual activity questions not being asked.  
  Excludes participants with dementia.

### Appendix 3

*Association between sexual activity or physical tenderness in the previous 6 months, with mild cognitive impairment* (MCI) or Mini Mental State Examination (MMSE)*

|                          | Partnered | Unpartnered |                  |                  |                  |
|--------------------------|-----------|-------------|------------------|------------------|------------------|
|                          | male      | female      | male             | female           |                  |
|                          | OR        | p value     | OR               | p value          |                  |
|                          | OR        | p value     | OR               | p value          |                  |
| MCI assessment           |           |             |                  |                  |                  |
| Sexual activity          |           |             |                  |                  |                  |
| Model 1*                 | 1.07      | 0.7         | 2.36             | 0.003            | 3.35             | 0.3               | 0.53             | 0.3               |
| Model 2b                 | 1.05      | 0.8         | 1.55             | 0.3              | 1.43             | 0.7               | 0.23             | 0.09              |
| Physical tenderness      |           |             |                  |                  |                  |
| Model 1*                 | 1.03      | 0.9         | 1.50             | 0.2              | 4.04             | 0.2               | 1.28             | 0.6               |
| Model 2b                 | 0.94      | 0.8         | 1.46             | 0.3              | 1.86             | 0.6               | 1.51             | 0.6               |
| Cognitive impairment assessment through MMSE |           |             |                  |                  |                  |
| Sexual activity          |           |             |                  |                  |                  |
| Model 1*                 | 1.51      | 0.04        | 1.55             | 0.09             | 1.42             | 0.6               | 0.86             | 0.09              |
| Model 2b                 | 1.28      | 0.3         | 1.22             | 0.5              | 3.44             | 0.3               | N/A (n < 30)        |
| Physical tenderness      |           |             |                  |                  |                  |
| Model 1*                 | 1.59      | 0.03        | 2.14             | 0.002            | 1.71             | 0.4               | 1.60             | 0.4               |
| Model 2b                 | 1.82      | 0.01        | 1.94             | 0.02             | 4.16             | 0.2               | 5.35             | 0.1               |

* Model 1 is adjusted for age.  
  Model 2 is further adjusted for ADLs, and prevalent diabetes, CVD and cancer.  
  MCI, mild cognitive impairment; MMSE, mini mental state examination.
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