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Living Together, Loving Apart: Health, Sexuality and Relationships in Middle-Aged and Older Men in Europe

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ABSTRACT

Background: Over time, family structures have grown more complex, diversifying adult relationships. While research has compared marital, cohabiting and living apart together relationships based on quality and health, less is known about their sexual dynamics. Theoretical frameworks suggest that co-resident relationships may integrate sexuality differently from living apart together unions, where physical separation can either strengthen or weaken sexual intimacy. This study addresses this gap by analysing sexual function and satisfaction among men in marital, cohabiting and living apart together relationships.

Exploring the relationship between living apart together unions and sexual and hormonal aspects can enhance our understanding of the links between hormones and the social and relational dynamics of contemporary society.

Methods: We analysed cross-sectional data from the European Male Ageing Study, a non-interventional cohort study conducted in eight European countries from 2005 to 2008. The sample included 3259 men aged 40–79 years who reported their relationship status. Sexual function was evaluated using the validated European Male Ageing Study sexual function questionnaire. Hormonal, lifestyle and health indicators were also collected. Statistical analyses, including ANCOVA, were used to adjust for confounders such as age, education, lifestyle and comorbidities.

Clotilde Sparano and Giammarco Alderotti contributed equally to this work.

Results: Living apart together relationships were reported by 6.9% of the cohort, similar to the 7.0% in cohabiting relationships, while 86.0% were married. Living apart together men were younger, more educated, and had a higher prevalence of smoking compared to married men. Compared to those in co-residential relationships, men in living apart together relationships showed higher levels of free testosterone, greater sexual desire and satisfaction, and increased frequency of sexual activity, morning erections and masturbation. Cohabiting men were in an intermediate position, with married men reporting the lowest sexual desire and activity.

Conclusions: Our findings align with previous research, suggesting that living apart together relationships are associated with higher levels of sexual function and satisfaction. However, this is observed without the broader benefits of co-residence, such as emotional security, shared responsibilities and partner's health oversight. Further research is needed to clarify the interplay between relationship type, sexual and health well-being.

1 | Introduction

Over the last decades, family complexity has increased remarkably in high-income countries, resulting in a multitude of family arrangements [1, 2]. Family and relationship research has increasingly recognised living together without marriage (cohabitation) and living apart together (LAT) as distinct forms of partnership [1, 2], while marriage has gradually lost its centrality [3]. Nonetheless, existing research comparing marriages with cohabitations and LAT unions has mostly focused on relationship quality and health dynamics [2, 4], but disregarding sexual dynamics [5].

There are different theoretical perspectives on the role of sexuality within co-resident (marriage and cohabitation) versus LAT relationships. Among co-resident couples, differences in relationship satisfaction between cohabitors and marrieds were more pronounced in the past. As cohabitation became a socially accepted institution and democratised across social groups, these differences tended to disappear [6, 7]. In LAT partnerships, lacking shared financial and domestic duties often makes sexual fidelity a central foundation for commitment [8–10]. Unlike co-residents who intertwine through children and finances, LAT partners maintain greater autonomy. This independence allows relationships to focus on affection and emotional support, where sexual intimacy provides a vital bond [11]. However, other research suggests that physical separation can diminish the role of sexuality in these relationships: when partners lead separate lives, sexual intimacy may be less important, and overall commitment levels may be lower than those found in co-resident unions [8].

Despite increasing interest in the difference between cohabitation and LAT relationships, empirical studies comparing sexual patterns across different relationship types remain scarce. One of the few exceptions is a study by Ciritel [9], which found that individuals in cohabitation relationships share the same levels of sexual intimacy as those married. In addition, although LAT partners reported higher levels of sexual intimacy than partners living together (cohabiting or married), they were often less satisfied with their overall relationship. Another recent study by Sparano et al. [10] found that men in LAT relationships reported better sexual functioning, higher frequency of sexual intercourse, and elevated testosterone levels than men in co-resident couples, even after adjusting for lifestyle and health differences. Despite these apparent benefits, the study also highlighted that LAT relationships were often a source of familial conflict and tended to be of shorter duration. Moreover, in a longitudinal analysis [10], compared to cohabiting, those in LAT relationships had a significantly higher risk of major adverse cardiovascular events (MACEs). A limitation of that study, however, was that the authors did not distinguish between married and cohabiting relationships, thus failing to provide an encompassing view of sexuality across union types. Additionally, the research was based on a group of men who were seeking treatment for sexual dysfunction at an andrology clinic in Italy. Consequently, its findings are confined to a cohort where MACE events are overrepresented [11, 12] and may thus not be generalisable to the general population.

In the present study, we address these limitations by analysing sexual function and satisfaction among a community-based sample of men, comparing men in married, cohabiting and LAT relationships. Overall, this study offers a more comprehensive view of the sexual landscape of contemporary relationships among middle-aged and older men, also by exploring connections between sexual desire, sexual function, and hormonal and health parameters. New findings linking relational and hormonal patterns may unveil unknown dynamics shaping modern familial unions.

2 | Materials and Methods

2.1 | Study Population

The present analyses are based on cross-sectional data from the European Male Aging Study (EMAS), a non-interventional cohort study of male ageing in Europe. Details regarding recruitment, response rates and assessments have been described elsewhere [13, 14]. Briefly, 3369 non-institutionalised men aged 40–79 years were recruited from municipal or population registers in eight centres: Florence (Italy), Leuven (Belgium), Łódź (Poland), Malmö (Sweden), Manchester (UK), Santiago de Compostela (Spain), Szeged (Hungary) and Tartu (Estonia). Stratified random sampling was used to recruit equal numbers of men into each of four age bands (40–49 years, 50–59 years, 60–69 years and 70–79 years). Participants were invited by letter to complete a short postal questionnaire and to attend a screening at a local clinic. There were no specific exclusion criteria, apart from the ability to provide written informed consent. Overall, the mean

TABLE 1 | Socio-demographic and clinical characteristics of the sample.

	Live with wife (*N* = 2564, 86.0%)	Live with partner (*N* = 210, 7.0%)	LAT (*N* = 207, 6.9%)	*p*-value[a] overall
Age (years), mean (SD)	59.99 (10.76)	55.30 (10.77)	57.83 (10.95)	**<0.001**
BMI (kg/m^2), median [IQR]	27.33 [25.01, 29.87]	27.03 [24.47, 30.03]	26.87 [24.33, 29.19]	0.377
Waist (cm), median [IQR]	97.80 [91.20, 104.90]	97.99 [89.77, 105.67]	98.00 [90.00, 105.00]	0.926
Fatherhood (yes), *N* (%)	2400 (94.1)	174 (82.9)	155 (74.9)	**<0.001**
Centre, *N* (%)				
Florence	371 (90.3)	15 (3.6)	25 (6.1)	**<0.001**
Leuven	366 (90.1)	23 (5.7)	17 (4.2)	
Łódź´	322 (88.2)	19 (5.2)	24 (6.6)	
Malmo	251 (74.0)	48 (14.2)	40 (11.8)	
Manchester	324 (91.8)	14 (4.0)	15 (4.2)	
Santiago	327 (91.6)	15 (4.2)	15 (4.2)	
Szeged	310 (82.4)	25 (6.6)	41 (10.9)	
Alcohol, *N* (%)				
≤1 per week	1072 (42.1)	96 (45.9)	101 (48.8)	**0.002**
1–4 per week	852 (33.4)	76 (36.4)	78 (37.7)	
>4 per week	625 (24.5)	37 (17.7)	28 (13.5)	
Current smoker (yes), *N* (%)	485 (19.1)	72 (34.3)	59 (28.8)	**<0.001**
Level of education, *N* (%)				
Primary	77 (3.1)	2 (1.0)	6 (3.0)	**0.017**
Secondary	1121 (44.6)	89 (42.8)	69 (34.7)	
Higher	1313 (52.3)	117 (56.2)	124 (62.3)	
No. of morbidities, *N* (%)				
None	1276 (50.6)	110 (52.6)	120 (58.5)	**0.005**
1 morbidity	675 (26.8)	67 (32.1)	56 (27.3)	
>1 morbidity	570 (22.6)	32 (15.3)	29 (14.1)	

Note: Bold numbers highlight significant comparisons. Unadjusted Kruskal–Wallis test or unadjusted ANOVA were used to compare differences across groups for continuous variables with non-normal or normal distributions; Fisher exact test was used to compare differences across categorical variables.

Abbreviations: BMI, body mass index; IQR, interquartile range; LAT, living apart together.

[a]*p*-values refer to comparisons among the three groups.

response rate for full participation in the study was 41%. The study was funded by the European Union, and ethical approval was obtained under local institutional requirements at each centre. In the present study, only subjects who provided information on the type of their sexual relationship were considered ($n = 3259$). The socio-demographic and clinical characteristics of the sample are reported in Table 1, stratified by the type of union (married, cohabiting, LAT).

2.2 | Evaluation

Participants completed a postal questionnaire at baseline that collected information about self-reported health, employment, education, smoking, alcohol consumption and the presence of concomitant morbidities [13, 14]. Participants subsequently attended a research clinic and completed further questionnaires including Beck's depression inventory (BDI, a tool that assesses depressive symptoms [15]), the Short Form 36 health survey (SF-36, a tool that assesses health related quality of life [16]), International Prostatic Symptom Score (IPSS, a tool that investigates urinary function [17]), the adverse life event scale (ALE, a tool that assesses previous threatening experiences in the last 6 months [18]) and Physical Activity Scale for the Elderly (PASE, an instrument that measures the level of physical activity for older individuals [19]). Subjects then completed the validated EMAS sexual function questionnaire (EMAS-SFQ [20]) in private. The EMAS-SFQ consists of 16 items assessing sexual functioning, sexual function-related distress and change in sexual functioning compared to 1 year ago, and it has been found to exhibit excellent reliability and validity [20]. A single item was used for describing the type of relationship: 'Please tick one statement that best describes your circumstances: (1) I have been living with my wife; (2) I have been living with my partner; (3) I have a sexual partner, but we did not live together; (4) I do not have a sexual partner'.

Anthropometric measurements were made including waist circumference, and height and weight from which body mass index (BMI) was calculated (kg/m^2) [13, 14].

A single fasting morning (before 10:00 h) venous blood sample was obtained and processed serum stored at −80°C. Measurement of prolactin (PRL) and thyroid stimulating hormone (TSH), free thyroxin (FT4) and sex hormone binding globulin (SHBG) were performed using chemiluminescence immunoassays. The lower limits were 6.3 mU/L, 0.01 mU/L, 1.3 pmol/L and 0.02 nmol/L for PRL, TSH, FT4 and SHBG, respectively. The coefficients of variation (CV) were 5.30%, 3.44%, 1.95% and 5.30% within runs and 2.50%, 2.44%, 3.31% and 6.60% between runs for PRL, TSH, FT4 and SHBG, respectively. A validated gas chromatography–mass spectrometry (GC–MS) system [21] was used to analyse total testosterone (T) (lower limit of quantification [LLOQ], 0.17 nmol/L; intra-assay coefficient of variation (CV), 2.9%; interassay CV 3.4%). GC–MS analyses were performed in the Laboratory of Molecular Endocrinology, Laval University, Quebec. Calculated free T and E2 were derived using the Vermeulen formula as previously described [22]. Analyses for total cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides, haemoglobin, creatinine, albumin, calcium, sodium, potassium and fasting glucose were performed locally in all centres using commercially available enzymatic methods.

2.3 | Causal Framework and Theoretical Assumptions

Given the cross-sectional nature of this study, direct establishment of temporal precedence or causality is precluded. Based on this premise, we developed a directed acyclic graph (DAG) to map the hypothesised associations between LAT status and testosterone levels. Our analysis focuses on identifying the net association between these variables while adjusting for known covariates identified within this theoretical structure.

2.4 | Statistical Analysis

Continuous variables are expressed as the mean ± SD or median (interquartile range [IQR]) when normally or non-normally distributed, respectively. Categorical variables are expressed as percentages. Alcohol consumption was categorised into three groups: less than once per week, at least once a week although less than 5 days per week, and 5 or more days per week. The number of comorbidities was categorised as either none, one or more than one. A Kruskal–Wallis (with post hoc Bonferroni correction), Fisher's exact test or ANOVA (with Tukey post hoc correction) were used to compare differences across the relationship groups (married, cohabiting, LAT), when applicable. Unpaired two-sided Student's *t*-tests were used to compare the means of normally distributed variables between groups. For non-normally distributed variables, the Mann–Whitney *U*-test was used to compare differences between individual groups. ANCOVA were used to estimate the effect of relationship type (cohabiting with wife, partner and LAT relationship) on continuous outcomes. Post hoc Bonferroni's test was applied. Logistic regression or multivariable linear regression analyses adjusted for age, education, lifestyle, centre and comorbidities were used to explore the association across the relationship groups and dichotomic or continuous outcomes, respectively. In particular, multivariable linear regression analysis was used for the relationship between sexual function variables and sex hormone levels within individual relationship groups. To ensure the robustness of our weighting strategy, we calculated standardised mean differences (SMDs) for all the main confounding covariates (age, education, lifestyle, comorbidities and LDL levels), adopting a threshold of <0.1 to indicate negligible imbalance. Additionally, we performed a health-selection check via a falsification test using the IPSS as a placebo outcome. Falsification tests showed no substantial evidence of residual confounding that would clinically alter the interpretation of the main findings (not shown). Sensitivity analyses were performed to test the robustness of the primary model. These included centre-level inverse-probability weighting (IPW) to account for varying response rates across sites (30%–55%) and multiple imputation by chained equations (MICE, $m = 20$) to address missingness in the relationship status variable. In all models, the recruitment centre was included as a fixed effect (not shown). DAGs were generated using Mermaid (version 11.12.0), an open-source JavaScript-based diagramming and charting tool [23]. All analyses were performed using SPSS (version 27; IBM, Armonk, NY, USA). Data processing and statistical modelling were carried out in R (v4.5.2) [24]. In particular, the WeightIt package was employed to implement Overlap Weighting (ATO) and to ensure robust covariate balancing between the study groups.

3 | Results

3.1 | Subject Characteristics

Of the 3259 men aged 40–79 years who reported their relationship status, the majority ($N = 2981$, 91.5%) reported being in a relationship or having a sexual partner. Table 1 summarises the socio-demographic, lifestyle and health characteristics of subjects categorised according to the relationship type, including being married (living with a wife), cohabiting (living with a partner) and LAT. See Table S1 for a more detailed analysis of differences among groups. The majority ($N = 2564$, 86.0%) reported living with a wife, with a small proportion either cohabiting ($N = 210$, 7%) or LAT ($N = 207$, 6.9%). Married men were older than those reporting other types of couple relationships (overall $p < 0.01$). By centre, those living in Florence were most likely to be married ($N = 371$, 90.3%) and those in Malmo least likely to be married ($N = 251$, 74%). The proportion of men in LAT relationships was highest in Malmo ($N = 40$, 11.8%) and Szeged ($N = 41$, 10.9%) and lowest in Santiago ($N = 15$, 4.2%).

After adjusting for age, there were differences in lifestyle according to the type of relationship (all $p < 0.05$, data not shown). Hence, all the following relationships were adjusted for age and lifestyle. In addition, according to Table 1, all the following relationships were also adjusted for education, centre and comorbidities. In a fully adjusted logistic regression model (including age, centre, lifestyle, education and comorbidity), fatherhood (yes/no) was less common for those in LAT relationships than for cohabiting married couples ($p < 0.001$), while no differences were observed for those living with a partner ($p = 0.081$).

TABLE 2 | Biochemical and hormonal data.

	Live with wife (*N* = 2564, 86.0%)	Live with partner (*N* = 210, 7.0%)	LAT (*N* = 207, 6.9%)	*p*-value[a] overall
Glucose (mmol/L), mean (SD)	5.64 (1.39)	5.57 (1.07)	5.56 (1.12)	0.571
Total cholesterol (mmol/L), mean (SD)	5.56 (1.05)	5.46 (0.99)	5.75 (2.91)	0.051
HDL (mmol/L), mean (SD)	1.42 (0.37)	1.37 (0.39)	1.36 (0.35)	**0.011**
Triglycerides (mmol/L), median [IQR]	1.29 [0.90, 1.85]	1.30 [0.84, 1.97]	1.29 [0.94, 1.97]	0.651
LDL (mmol/L), mean (SD)	3.45 (0.92)	3.41 (0.88)	3.68 (2.88)	**0.021**
PSA (ng/mL), median [IQR]	0.97 [0.59, 1.83]	0.83 [0.53, 1.38]	1.10 [0.76, 1.92]	0.664
FSH (UI/L), median [IQR]	6.06 [4.12, 9.37]	5.61 [4.13, 8.79]	6.09 [4.06, 8.87]	0.480
LH (UI/L), median [IQR]	5.16 [3.75, 7.04]	5.02 [3.72, 6.96]	5.39 [4.19, 7.28]	0.098
PRL (μg/L), median [IQR]	7.51 [5.75, 9.73]	6.94 [5.33, 9.19]	7.37 [5.93, 10.22]	0.192
SHBG (nmol/L), median [IQR]	39.05 [28.80, 51.80]	37.30 [28.52, 52.85]	37.80 [29.40, 51.10]	0.671
Total T (nmol/L), mean (SD)	16.38 (5.89)	16.83 (6.18)	17.43 (6.22)	**0.035**
Calculated free T (nmol/L), mean (SD)	288.80 (85.61)	305.09 (93.88)	316.73 (102.77)	**<0.001**
TSH (mUI/L), median [IQR]	1.45 [0.99, 2.04]	1.43 [1.00, 1.87]	1.41 [1.00, 2.11]	0.741
fT4 (pmol/L), median [IQR]	15.96 [14.29, 17.63]	15.70 [14.29, 18.02]	15.70 [13.77, 17.63]	0.201

Note: Bold numbers highlight significant comparisons. Unadjusted Kruskal–Wallis test or unadjusted ANOVA were used to compare differences across groups for continuous variables with non-normal or normal distributions.

Abbreviations: FSH, follicle stimulating hormone; fT4, free thyroxine; HDL, high density lipoprotein; IQR, interquartile range; LAT, living apart together; LDL, low density lipoprotein; LH, luteinizing hormone; *n*, number; PRL, prolactin; PSA, prostatic specific antigen; T, testosterone; TSH, thyroid stimulating hormone.

[a]*p*-values refer to comparisons among the three groups.

3.2 | Biochemical and Hormonal Variables and Relationship Type

Table 2 shows the biochemical and hormonal measurements by relationship type. See Table S1 for a more detailed analysis of differences among groups. When assessed in a fully adjusted aforementioned ANCOVA model, those reporting LAT relationships showed higher levels of total cholesterol than those living with a partner ($p = 0.032$, not shown) and a higher level of LDL cholesterol than married and living with a partner couple ($p = 0.029$ and 0.033, respectively, not shown).

ANCOVA model and post hoc Bonferroni test (adjusted for age, education, lifestyle, centre and comorbidities) confirm significant differences for calculated free testosterone (cFT), which was higher in LAT (300.43 ±16.06) than in married (280.51 ± 5.95, adjusted mean difference = −19.91, 95% CI: [−31.58, −8.26], $p = 0.002$) or cohabiting couples (278.46 ± 7.90, adjusted mean difference = −21.97, 95% CI: [−37.47, −6.47], $p = 0.018$) (Figure 1A). These findings were further confirmed by sensitivity analyses using both IPW-weighted and MICE-imputed models, which yielded consistent and stable effect sizes for the LAT group (data not shown). ANCOVA confirms no other significant differences in all the other hormonal parameters (not shown).

3.3 | Sexual Function and Relationship Type

Concerning sexual parameters, as derived by the EMAS-SFQ questionnaire, Table 3 shows the univariate analysis of the items across the three relationship types (i.e., married, living with a partner and LAT). See Table S2 for a more detailed analysis of differences among groups.

As shown in Figure 1B, the LAT cohort scored higher than all the other groups in rating question #2 concerning thinking about sex. In a fully adjusted ANCOVA model, LAT and living with a partner relationships scored higher than those living with a wife ($p < 0.001$ and 0.003, respectively, Figure 1B). In the LAT group, a close relationship was observed between thinking about sex and cFT, even after introducing the aforementioned covariates in a fully adjusted multivariable regression analysis (Figure 1C). In addition, in the LAT group, a fully adjusted multivariable linear regression showed that the level of sexual desire increased as a function of cFT (Figure 1D). A significant association between cFT and frequency of sexual desire was also observed in cohabiting couples, married or not ($\beta = 0.058$, $p = 0.005$ and $\beta = 0.201$, $p = 0.009$, respectively, not shown). In addition, the LAT group reported more often a less negative (i.e., positive) change in sexual desire during the last year than cohabiting couples, married or not ($p < 0.001$ and 0.03, respectively, not shown).

Those in LAT relationships and those living with a partner reported a greater frequency of sexual intercourse than married men (EMAS-SFQ question #5) (Figure 2A). In a fully adjusted multivariable linear regression, frequency of sexual intercourse was significantly associated with cFT in the LAT and married group ($\beta = 0.189$, $p = 0.01$ and $\beta = 0.069$, $p = 0.003$, respectively), but not in those cohabiting with a partner (not shown). At variance, frequency of non-penetrative sex (i.e., kissing, fondling, petting, etc., EMAS-SFQ question #6) was higher in those living with the partner than in LAT or in the married counterparts

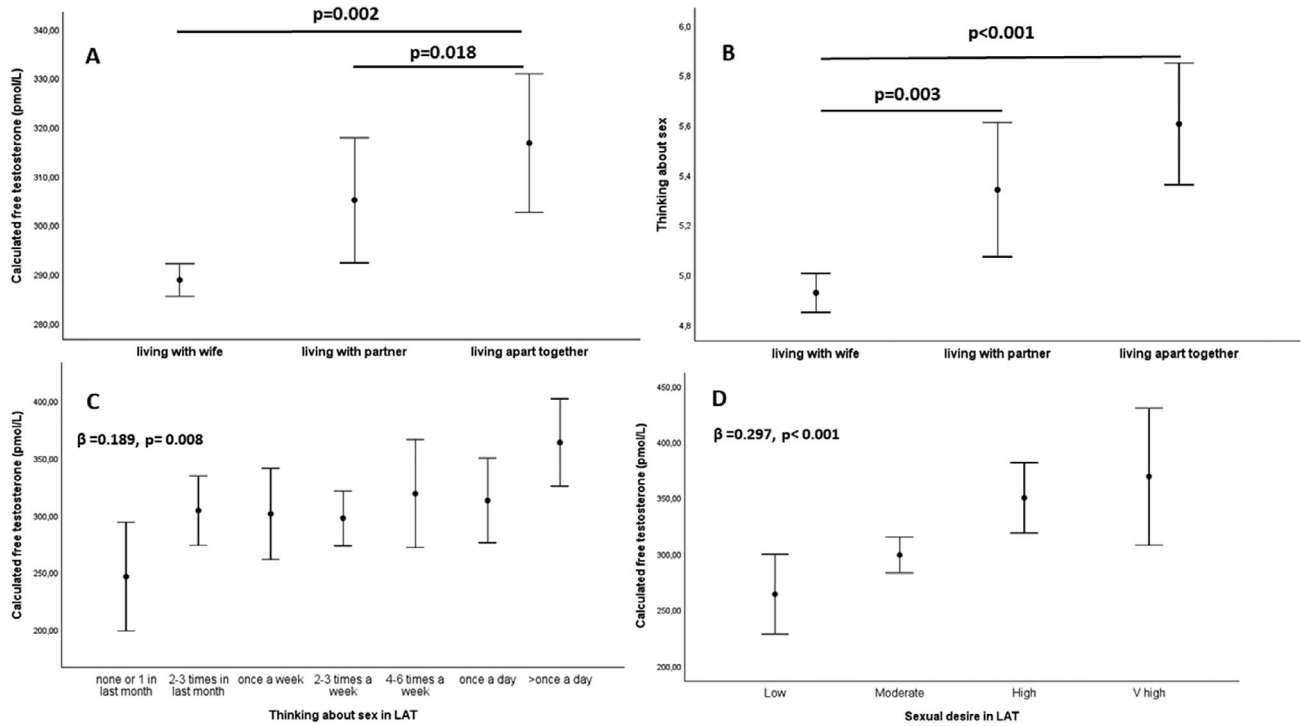

FIGURE 1 | Levels of calculated free testosterone (panel A) and thinking about sex (question #2 of the EMAS sexual function questionnaire, panel B) according to the different type of relationships (i.e., living with wife, living with partner and living apart together). Panels C and D show in the LAT group only the association between calculated free testosterone and frequency of thinking about sex and degree of sexual desire. Statistical analysis is derived from age-, lifestyle-, education-, centres- and number of comorbidity-adjusted ANCOVA model and post hoc Bonferroni test (panels A and B), and from a multivariable linear regression model after adjusting as before (panels C and D). The ordinate axis shows the error bars with the 95% confidence interval.

(Figure 2B). However, the frequency of non-penetrative sex was not associated with cFT in fully adjusted multivariable linear regression models in all the groups (not shown). LAT relationships were characterised by a greater frequency of autoeroticism (EMAS-SFQ question #7) than the cohabitant counterparts (Figure 2C). At fully adjusted multivariable linear regression, a significant association between frequency of masturbation and cFT was observed in married men ($\beta = 0.069$, $p < 0.001$), but not among cohabitors, although a tendency was present in LAT ($\beta = 0.143$, $p = 0.057$). According to question #9 of EMAS-SFQ, the LAT group reported more often a less negative (i.e., positive) change in overall sexual activity during the last year than in co-residential couples, married or not ($p < 0.001$ and 0.017, respectively, Figure 2D).

Importantly, the ability to obtain an erection good enough for sexual intercourse (EMAS-SFQ question #10) showed no significant differences among marriage, cohabitation and LAT relationships (not shown). Frequency of morning erections (EMAS-SFQ question #16) was greater in cohabiting and LAT men than in married men (Figure 3A). A fully adjusted multivariable linear regression model showed that, in the LAT group, this sexual parameter was significantly associated with cFT (Figure 3B). A similar association was also observed in couples living together, married or not ($\beta = 0.061$, $p = 0.003$ and $\beta = 0.155$, $p = 0.04$, respectively). LAT couples showed a lower decrease in morning erection in the last year (EMAS-SFQ question #18) compared to the married group (Figure 3C).

Higher sexual satisfaction (EMAS-SFQ question #19) was observed in the LAT cohort as compared to men living with a wife (Figure 3D). Sexual satisfaction did not appear to be associated with cFT, either in LAT couples or in the rest of the sample (not shown).

3.4 | Health-Related Factors, Quality of Life and Relationship Type

Characteristics of the couple relationship were investigated at a fully adjusted ANCOVA by analysing specific items of the EMAS-SFQ questionnaire and the ALE scale. Partner health, as perceived by the respondents (EMAS-SFQ), was reported as better in LAT couples than in the married ones, without differences from those cohabiting with a partner (Figure 4A). The number of ALEs was different according to the type of relationship (unadjusted Table 4), which was confirmed by fully adjusted ANCOVA, showing that married men reported lower ALE than the rest of the cohort (Figure 4B). In particular, men in LAT relationships scored higher in specific ALE questions, including a broken relationship or separation, than cohabitant couples (Figure 4C). In addition, men in LAT relationships reported moving home more frequently than married men, without a difference with those cohabiting with a partner (Figure 4C).

No significant differences were observed in SF-36 scoring when both aggregated physical and mental components were

TABLE 3 | Sexual function questionnaire scoring.

Question	Live with wife ($N = 2564$, 86.0%)	Live with partner ($N = 210$, 7.0%)	LAT ($N = 207$, 6.9%)	p-value[a] overall
How often did you think about sex (score), median [IQR]	5 [3.00, 7.00]	5 [4.00, 7.00]	5 [4.00, 7.00]	**<0.001**
Are you worried or distressed by your current level of sexual drive/desire? (score), median [IQR]	1 [1.00, 2.00]	1 [1.00, 2.00]	1 [1.00, 2.00]	0.882
Compared with a year ago, has your sexual drive/desire changed? (score), median [IQR]	3 [3.00, 4.00]	3 [3.00, 4.00]	3 [3.00, 3.00]	**<0.001**
How many times have you attempted sexual intercourse? (score), median [IQR]	4 [2.00, 5.00]	5 [3.00, 5.00]	4 [3.00, 5.00]	**<0.001**
Apart from when you attempted sexual intercourse, how frequently did you engage in activities such as kissing, fondling, petting, etc.? (score), median [IQR]	5 [3.00, 6.00]	5 [4.00, 7.00]	5 [3.00, 6.00]	**<0.001**
How often did you masturbate? (score), median [IQR]	1 [1.00, 3.00]	1 [1.00, 3.00]	2 [1.00, 3.00]	**<0.001**
Are you worried or distressed by the overall frequency of your sexual activities? (score), median [IQR]	2 [1.00, 4.00]	2 [1.00, 4.00]	2 [1.00, 4.00]	0.789
Compared with a year ago, has the overall frequency of your sexual activities changed? (score), median [IQR]	3 [3.00, 3.00]	2 [1.00, 4.00]	2 [1.00, 4.00]	**0.002**
Experience erectile problems (score), median [IQR]	2 [1.00, 3.00]	2 [1.00, 2.00]	2 [1.00, 2.00]	**0.007**
Are you worried or distressed by your current ability to have an erection? (score), median [IQR]	1 [1.00, 2.00]	1 [1.00, 2.00]	1 [1.00, 2.00]	0.085
Compared with a year ago, has your ability to have an erection changed? (score), median [IQR]	3 [3.00, 4.00]	3 [3.00, 3.00]	3 [3.00, 4.00]	**0.019**
When you had sexual stimulation, how often did you have the feeling of orgasm or climax? (score), median [IQR]	6 [3.00, 6.00]	6 [5.00, 6.00]	6 [5.00, 6.00]	**<0.001**
Are you worried or distressed by your current orgasmic experience? (score), median [IQR]	1 [1.00, 2.00]	1 [1.00, 2.00]	1 [1.00, 2.00]	0.723
Compared with a year ago, has the enjoyment of your orgasmic experience changed? (score), median [IQR]	3 [3.00, 3.00]	3 [3.00, 3.00]	3 [3.00, 3.00]	**0.002**
How frequently did you awaken with full erection? (score), median [IQR]	3 [1.00, 5.00]	4 [2.00, 5.00]	4 [2.00, 5.00]	**<0.001**
Are you worried or distressed by the frequency of your morning erections? (score), median [IQR]	1 [1.00, 1.00]	1 [1.00, 1.00]	1 [1.00, 1.00]	0.711
Compared with a year ago, has the frequency of your morning erections changed? (score), median [IQR]	3 [3.00, 3.00]	3 [3.00, 3.00]	3 [3.00, 3.00]	**0.034**
How satisfied have you been with your overall sex life? (score), median [IQR]	4 [2.00, 4.00]	4 [3.00, 4.00]	4 [3.00, 4.00]	**<0.001**
How satisfied have you been with your general (non-sexual) relationship with your partner? (score), median [IQR]	4 [4.00, 5.00]	4 [4.00, 5.00]	4 [4.00, 5.00]	**0.005**

Note: Bold numbers highlight significant comparisons. Unadjusted Kruskal–Wallis test was used to compare differences across groups for continuous variables with non-normal distributions.

Abbreviations: IQR, interquartile range; LAT, living apart together.

[a]p-values refer to comparisons among the three groups.

considered (Table 4). No relationships were also observed between the type of relationship and responses to other questionnaires, such as BDI (depression) and PASE (physical activity) (Table 4). Although IPSS scoring appeared different in an unadjusted analysis (Table 4), this finding was not confirmed in a fully adjusted ANCOVA (not shown). See Table S1 for a more detailed analysis of differences among groups.

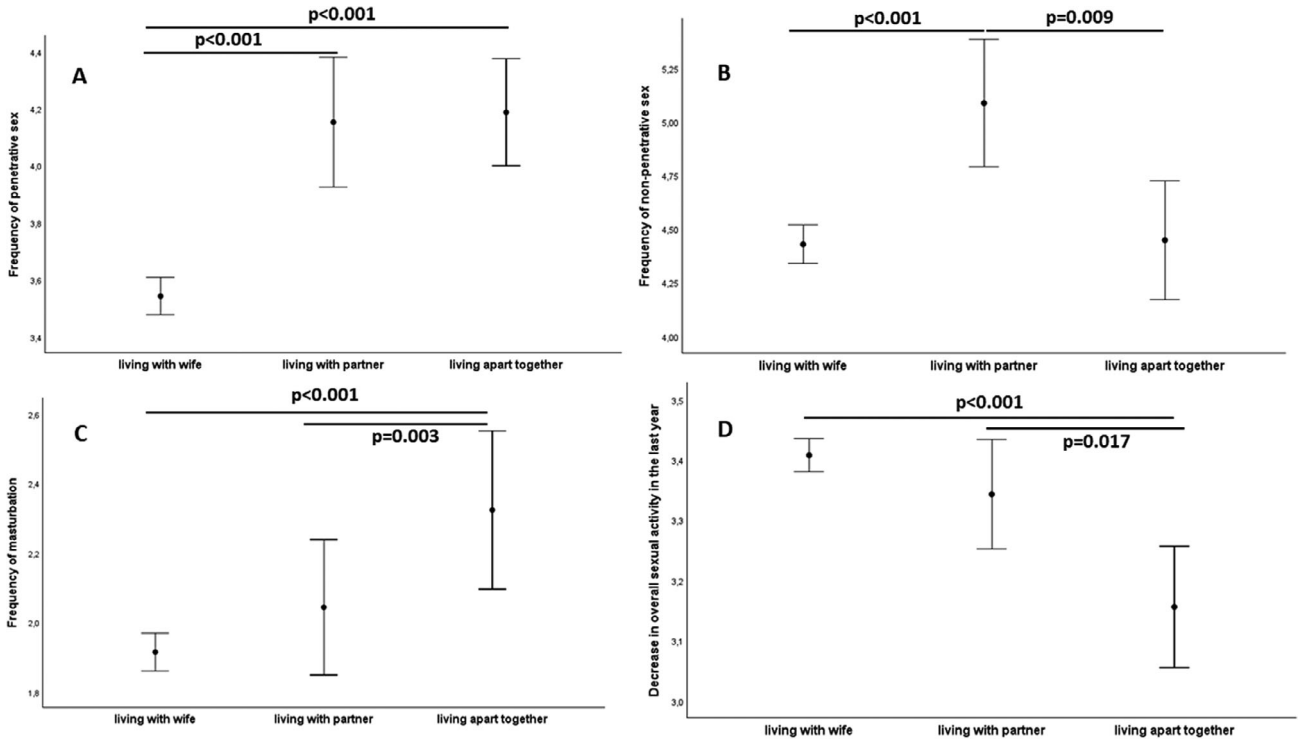

FIGURE 2 | Frequency of penetrative sex (panel A), non-penetrative sex (panel B), masturbation (panels C) and decrease in overall sexual activity in the last year (panel D) (question #5, #6, #7 and #9 of the EMAS-SFQ, respectively), according to different type of relationships (i.e., living with wife, living with partner and living apart together). Statistical analysis is derived from age-, lifestyle-, education-, centres- and number of comorbidity-adjusted ANCOVA models (and post hoc Bonferroni test). The ordinate axis shows the error bars with the 95% confidence interval.

4 | Discussion

This study provides a comprehensive examination of sexuality and types of relationships by directly comparing marriage (living with a spouse), cohabitation (living with a partner) and LAT (experiencing an intimate non-cohabiting relationship) in a large, multi-centre population survey.

Among middle-aged and older men from eight European countries, just over one in 15 reported being in a sexual relationship with a partner but not living together (LAT). Men in LAT relationships were younger and held a higher level of education than married men, who may prioritise autonomy and career development over cohabitation [25]. Compared to published data, which have estimated the prevalence of LAT relationships at 10% of all relationship types [25], the lower prevalence observed in the present study could be partially explained by the older age of the men (mean age 60 years) studied in the present cohort because the LAT model is more common in younger age groups. Indeed, in men of more advanced age, LAT relationships often stem from a separation, a broken relationship or the death of a partner, which prompts men to seek a new relationship that allows for individuality while respecting any pre-existing family links. Moving home is another factor associated with LAT that could lead to a transitory situation. In addition, cultural differences and the specific timeframe of data collection may have also contributed to this lower LAT rate than in other reports [25].

As previously reported in a different cohort [13], higher levels of cFT were observed in the LAT group compared to cohabiting couples, even after adjusting for several confounders. When compared to married men, those in LAT relationships showed overall a greater sexual desire and sexual satisfaction, a higher frequency of penetrative sex, morning erections and masturbation, as previously observed [10]. This result seems to contradict the hypothesis that physical separation may diminish the importance of sexuality in these relationships, instead reinforcing the idea that sexual intimacy is a vital bond in LAT [26]. Interestingly, in LAT men, all these aspects of sexuality were closely associated with the circulating levels of cFT, apart from sexual satisfaction. Sexual desire and frequency of morning erections are the most consistent correlates of higher testosterone levels [27–30], although they may also have many other determinants [31]. In fact, it is possible that the increased frequency of sexual activity may boost sexual desire and/or testosterone levels [32, 33]. Figure 5 presents a DAG summarising the potential associations between three competing pathways: (1) a behavioural induction path, (2) a selection effect (e.g., testosterone levels), and (3) latent confounding (e.g., personality traits). The DAG was utilised to guide our model specification and to explicitly acknowledge the potential for reciprocal influences or spurious correlations that cannot be fully addressed without longitudinal data.

We now report that subjects in LAT relationships not only think about sex more than those in cohabiting relationships, but also that sexual desire in LAT has increased in the past year. Married men showed the lowest level of sexual desire and morning erections and a lower frequency of penetrative and non-penetrative sex than their unmarried counterparts.

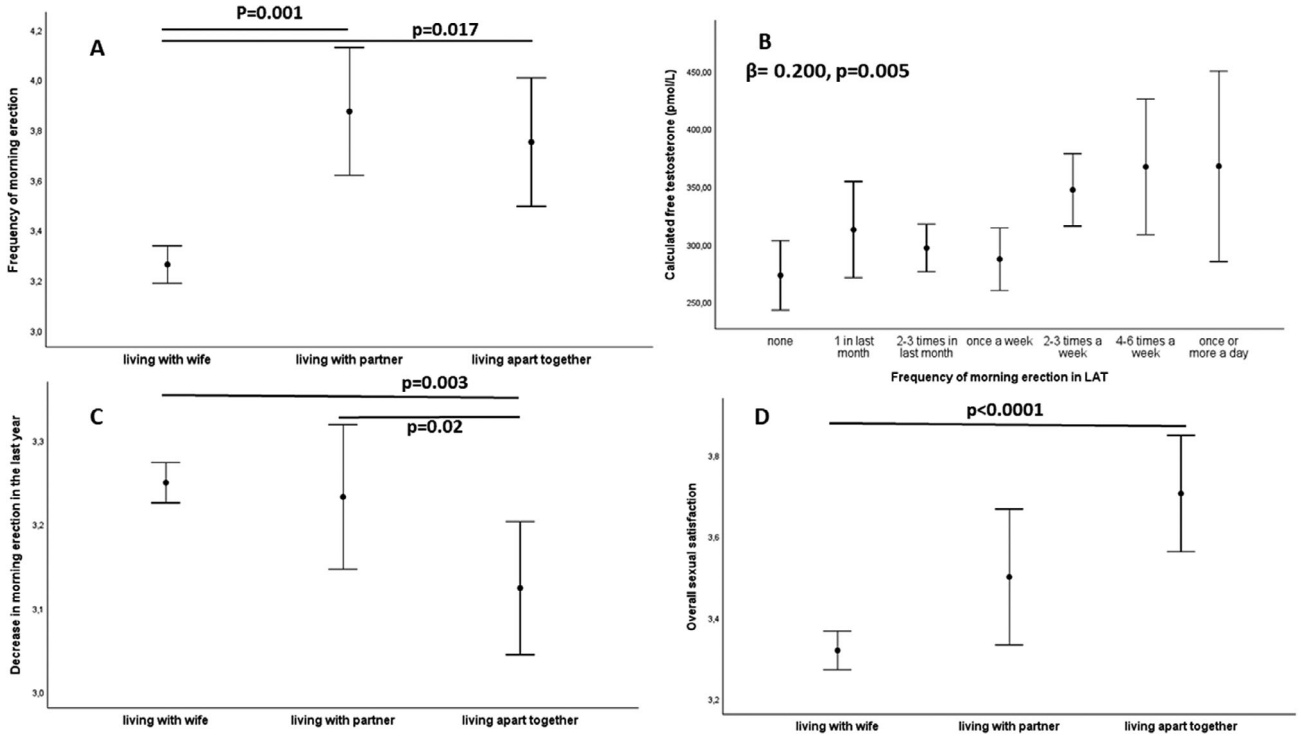

FIGURE 3 | Frequency of morning erection (panel A), decrease in morning erection in the last year (panel C) and overall sexual satisfaction (panel D) (question #16, #18 and #19 of the EMAS-SFQ, respectively), according to the different types of relationships (i.e., living with wife, living with partner and living apart together). Panel B shows in the LAT group only the association between calculated free testosterone and morning erection. Statistical analysis is derived from age-, lifestyle-, education-, centres- and number of comorbidity-adjusted ANCOVA models (and post hoc Bonferroni test) (panels A, C and D), and from multivariable linear regression after adjusting as before (panel B). The ordinate axis shows the error bars with the 95% confidence interval.

Differences between men in LAT and those unmarried but in cohabitation with a partner were more subtle and only resulted in statistically significant differences regarding a higher frequency of autoeroticism and a more positive change in sexual activity, as compared to the previous year. Generally, cohabiting relationships seem to occupy an intermediate position between LAT unions and marriages across most of the analysed variables.

Interestingly, non-penetrative sex was more often reported in unmarried co-residential relationships than in LAT or in married men. On the one hand, men in LAT relationships may be more inclined to seek bonding behaviours—potentially including sexual intimacy—to strengthen the couple's connection. On the other hand, more active sexual behaviours typical of LAT relationships may themselves have a positive effect on testosterone levels.

Nevertheless, in spite of higher cFT levels and better sexuality, men in LAT show more often a smoking behaviour and increased LDL levels, most probably because the everyday health oversight of the female partner is virtually absent [34]. Accordingly, we previously showed that men in LAT relationships are more prone to forthcoming MACE than their cohabitant counterparts [10]. In line with this view, married men showed the lowest share of ALEs of the sample. Similarly, a better couple relationship is associated with a reduced cardiovascular risk even after the adjustment for conventional confounding factors [34–36], but not for sleep quality or loneliness. Alternative explanations may be that unhealthy individuals are more likely than others to be in LAT because of issues around commitment to be cohabiting, which may restrict their unhealthy lifestyle, or that female partners are less willing to cohabit because of their male partners' lifestyle. This aligns with evidence indicating that relationship stability and commitment levels tend to be lower in LAT unions compared to co-resident (married and cohabiting) couples [5].

4.1 | Study Limitations

Our study had several limitations that should be acknowledged. First, its cross-sectional design precludes establishing directionality in cause-and-effect relationships. Second, the item used to define LAT does not accurately capture certain nuances of such relationships, such as the deliberate choice to live apart while maintaining romantic principles and relationship stability. It is limited to identifying a lack of cohabitation, which could also result from external obstacles or be merely transitional. Third, we recognise that the sample size of the three groups of relationships (marrieds, cohabitors, LATs) varies widely. However, when the proportion of one or more categories is small, this would tend to reduce the chance of finding significant associations, although probably not undermine the positive findings that we have observed. The EMAS data are approximately two decades old; therefore, potential shifts in societal perspectives may have occurred. Furthermore, the dataset lacked information on relationship duration, as well as partner age and sex—even for a subpopulation—preventing us from controlling for these

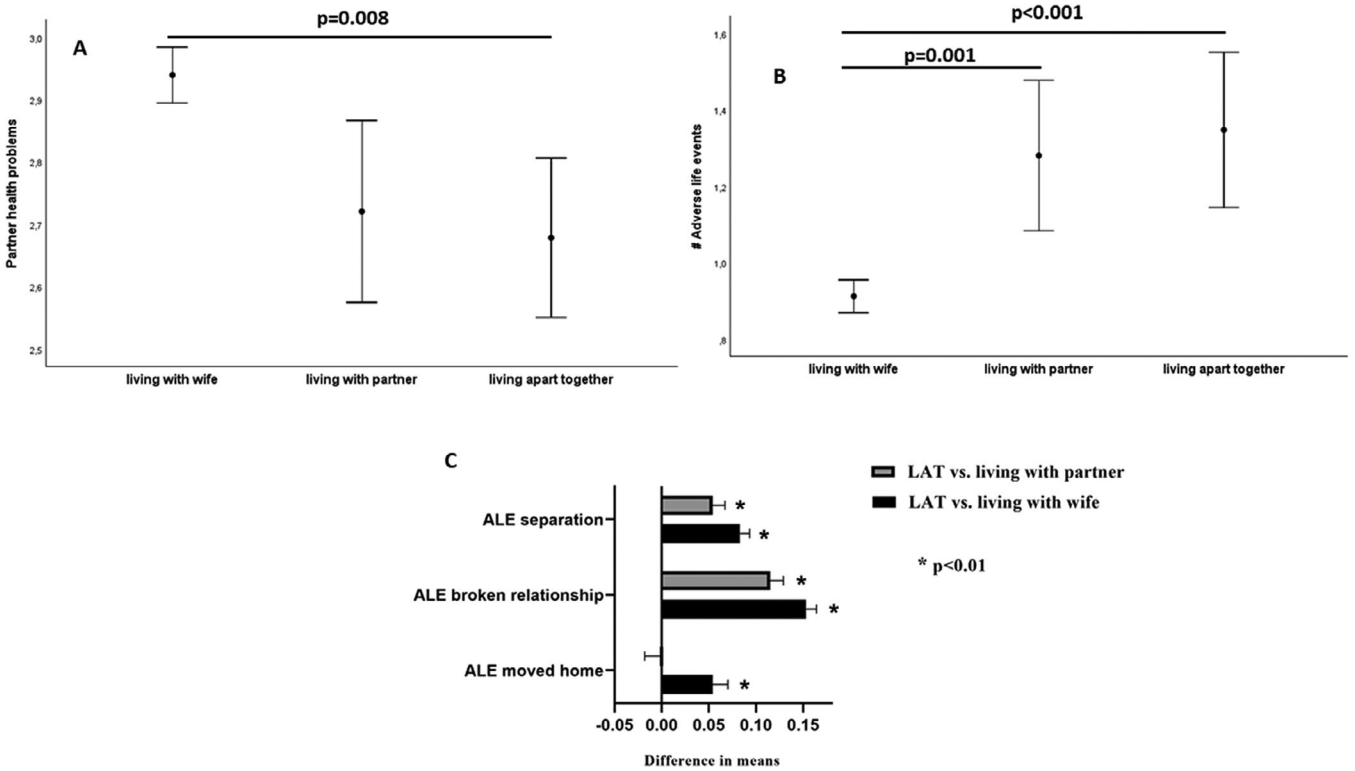

FIGURE 4 | Partner health problems (panel A) and the number of adverse life events (panel B), according to different types of relationships (i.e., living with wife, living with partner and living apart together). The ordinate axis shows the error bars with the 95% confidence interval. Panel C shows the adjusted comparison between LAT (reference) versus living with wife or with partner according to different items of the ALE questionnaire. The abscissa indicates difference in means of the indicated ALE items. Statistical analysis is derived from age-, lifestyle-, education-, centres- and number of comorbidity-adjusted ANCOVA models (and post hoc Bonferroni test).

TABLE 4 | Summary data of questionnaire scoring.

	Live with wife ($N = 2564$, 86.0%)	Live with partner ($N = 210$, 7.0%)	LAT ($N = 207$, 6.9%)	p-value[a] overall
BDI total (score), median [IQR]	5.00 [2.00, 9.00]	5.00 [2.00, 10.00]	5.00 [2.00, 10.00]	0.980
ALE total (score), median [IQR]	1.00 [0.00, 1.00]	1.00 [0.00, 2.00]	1.00 [0.00, 2.00]	**<0.001**
IPSS total (score), median [IQR]	4.00 [1.00, 8.00]	3.00 [1.00, 6.00]	3.00 [1.00, 8.00]	**0.004**
PASE total (score), median [IQR]	199.89 [131.71, 260.61]	195.14 [139.12, 254.61]	208.27 [137.18, 272.34]	0.388
SF-36 mental component score (score), median [IQR]	53.85 [47.04, 58.34]	54.21 [46.73, 57.90]	52.54 [45.40, 58.11]	0.231
SF-36 physical component score (score), median [IQR]	52.14 [46.06, 56.12]	51.69 [45.23, 55.68]	52.84 [46.80, 55.63]	0.800

Note: Bold numbers highlight significant comparisons. Unadjusted Kruskal–Wallis test was used to compare differences across groups for continuous variables with non-normal distributions.

Abbreviations: ALE, adverse life event scale (a tool that assesses previous threatening experiences); BDI, Beck's depression inventory (a tool that assesses depressive symptoms); IPSS, International Prostatic Symptom Score (a tool that investigates urinary function); IQR, interquartile range; LAT, living apart together; PASE, Physical Activity Scale for the Elderly (an instrument that measures the level of physical activity for older individuals); SF-36, Short Form 36 health survey (a tool that assesses health related quality of life).

[a] p-values refer to comparisons among the three groups.

potential confounders. In particular, considering that the length of the relationship and age of the partner may affect male sexual parameters, the present results may be different in other contexts, where these variables are taken into account. However, it is important to note that in another cohort, where this information was available [10], similar results to the present ones were reported. Data on same-sex couples are missing. Finally, the study population is limited to men over the age of 40 years; consequently, the results may not be generalisable to younger cohorts. Additionally, the cross-sectional design, reliance on self-reported data, and potential selection bias—compounded by the absence of partner-level variables such as age and menopausal status—pose further limitations to the interpretability of these findings.

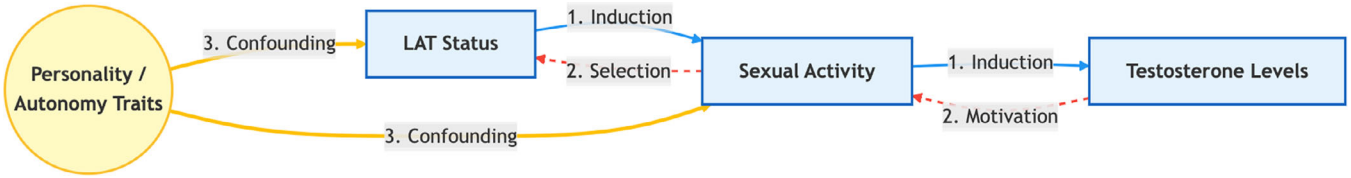

FIGURE 5 | Directed acyclic graph (DAG) integrates three competing longitudinal hypotheses regarding the association between living apart together (LAT) status and endocrine profiles. Blue solid arrows (behavioural induction): represents the environmental pathway. It hypothesises that the LAT arrangement serves as an exogenous trigger that maintains sexual novelty or frequency, which subsequently upregulates testosterone (T) production through the hypothalamic–pituitary–gonadal axis. Red dashed arrows (selection effect): represents reverse causality. It suggests that baseline biological traits (higher T) drive sexual motivation and a preference for autonomy, leading individuals to self-select into non-cohabiting (LAT) relationships. Yellow thick arrows (common cause): represents latent confounding. In this scenario, the correlation between LAT and T is spurious, driven by unobserved third factors (U) such as personality traits (e.g., high sensation seeking) or a strong preference for autonomy.

5 | Conclusions

Overall, the present paper underscores a dual nature of LAT relationships. On the one hand, LAT relationships may offer sexual benefits, reinforcing emotional intimacy and increasing sexual frequency. Cohabiting men (those living with a partner without marriage) occupied an intermediate position between LAT and married men, with married individuals reporting the lowest sexual desire and frequency of sexual activity. On the other hand, the lack of a co-residential union is associated with adverse health effects, possibly because of weaker health oversight by a partner [34]. This study underscores the need for further research into how relationship types interact with sexual well-being and health outcomes in later life. We believe these findings represent a significant contribution to the field, with the potential to inform future research and clinical interventions. Future studies should therefore investigate strategies to mitigate potential health risks while preserving the unique benefits associated with LAT relationships.

Author Contributions

Mario Maggi conceived the study. Mario Maggi, Clotilde Sparano and Giammarco Alderotti performed the statistical analyses. All the authors drafted and approved the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest prejudicing the impartiality of the present study.

Data Availability Statement

Data are available from the corresponding authors, M.M. and D.V., upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting file 1: andr70231-sup-0001-tableS1-S2.docx