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MORTALITY

Sex differences in health and mortality in Moscow and Denmark

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Abstract In high income countries females outlive men, although they generally report worse health, the so-called male–female health-survival paradox. Russia has one of the world's largest sex difference in life expectancy with a male disadvantage of more than 10 years. We compare components of the paradox between Denmark and Moscow by examining sex differences in mortality and several health measures. The Human Mortality Database and the Russian Fertility and Mortality Database were used to examine sex differences in all-cause death rates in Denmark, Russia, and Moscow in 2007–2008. Self-reported health data were obtained from the Study of Middle-Aged Danish Twins (n = 4,314), the Longitudinal Study of Aging Danish Twins (n = 4,731), and the study of Stress, Aging, and Health in Russia (n = 1,800). In both Moscow and Denmark there was a consistent female advantage at ages 55–89 years in survival and a male advantage in self-rated health, physical functioning, and depression symptomatology. Only on cognitive tests males performed similarly to or worse than women. Nevertheless, Muscovite males had more than twice higher mortality at ages 55–69 years compared to Muscovite women, almost double the ratio in Denmark. The present study showed that despite similar directions of sex differences in health and mortality in Moscow and Denmark, the male–female health-survival paradox is very pronounced in Moscow suggesting a stronger sex-specific disconnect between health indicators and mortality among middle-aged and young-old Muscovites.

Keywords Sex differences · Cross-national comparison · Health · Mortality · Russia · Denmark

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Introduction

The fact that women live longer than the men at all ages in all countries is well established in the literature [1, 2], whereas the direction and magnitude of sex differences in health vary across measures of health and geographic settings. Cross-country comparisons of sex differences in health based on survey data in 11 European countries, US, Japan, and England concluded that women have lower grip strength, worse physical functioning, and higher levels of depression symptomatology compared with their male counterparts [3–5]. Studies have also found that men suffer more from diseases with high lethality, while more women survive to older age with less fatal but disabling conditions [3, 6]. This can partially explain the known male–female health survival paradox noted by Nathanson [7] in the 1970s that men live shorter but they are healthier than the same-aged women. However, inconsistent results were reported for sex differences in other morbidities, such as lung conditions, diabetes, stroke, hypertension across different age groups and countries suggesting that the direction and magnitude of sex differences in health depends on a selected health indicator [8, 9].

The sex difference in life expectancy (LE) in Denmark increased after World War II until the last two decades of the twentieth century reaching the level of 6 years [10] and continuously declined afterwards to 4.2 years in 2009 [11]. LE in Russia has been always substantially lower than in Europe and the US and also has tended to decrease further since the late 1960s [12, 13]. In 2009, LE was 74.7 and 62.7 years in Russian women and men, respectively. The sex gap of 11.9 years was the second highest in the world (after Kazakhstan) and about three fold higher than that in Denmark, which, in turn, has had relatively poor performance with regard to LE among western EU countries [11]. The female-male gap in LE in Russia increased from 1959 (8.3 years) to 2005 (13.6 years) with the only substantial decline in 1986–1987 (9.4 years) due to Gorbachiev's anti-alcohol campaign and a steeper decline in male mortality [11, 14]. Although a narrowing of sex differential life expectancy in Russia has been observed since 2006, its further development is hard to predict.

Midlife mortality from cardiovascular disease as well as deaths due to violence, accidents and alcohol-related causes at young adult ages were found to be extremely high in Russia and were the main contributors to the declining life expectancy in the country from 1988 to 2000 [12]. However, higher mortality rates in Russia were observed also at older ages suggesting that the Russian population had worse health compared to old-aged populations elsewhere. A cross-sectional comparison of self-rated health and physical functioning showed that middle-aged Russians and Swedes had similar prevalence of poor self-rated health and disability, but after about age 45 the prevalence of poor general health and mean scores for physical functioning became substantially worse in Russia as compared to Sweden [15]. Russian men and women had much steeper decline in probability of being healthy in comparison not only to the populations in Western Europe, but also to the former communist Eastern EU countries [16]. Similarly, almost no difference at younger ages and worse levels of cognitive outcomes at older ages were indicated in Russia compared with the Czech Republic [17].

International comparison studies allow researchers to generalize the direction and relative size of sex differences in various health outcomes and find explanations for these differences. Most studies have been based on surveys in the low-mortality nations, whereas less is known about how similar are the directions and size of male–female difference in various health domains in Russia. The present study describes sex gap in mortality rates in Denmark, Russia, and Moscow and sex differences in several health outcomes in Denmark and Moscow among individuals aged 55–89 years. It examines whether the direction and magnitude of the sex gap in selected health measures previously found by international comparison studies can be generalized also to Moscow, a geographic setting with very different health trends, health and social systems, and culture.

Methods

Study population

The study was based on data from the Study of Middle-Aged Danish Twins (MADT) and the Longitudinal Study of Aging Danish Twins (LSADT) previously described in detail elsewhere [18, 19]. Eligible participants were identified through the Danish Twin Register covering twin pairs born in 1870–2004 and were representative of the background population [20, 21]. The MADT represented a random sample of 120 twin pairs from each birth cohort from 1931 to 1952, aged 45–68 years in 1998 (n = 4,314).

The LSADT involved Danish twins aged 75 years and older and residing in Denmark by January 1995 when the baseline survey was carried out. The follow-up waves were conducted every second year until 2005 and new participants aged at least 70 years were added in 1997, 1999, and 2001. In total, 4,731 twins completed the intake assessment. The core questions and tests remained the same at all surveys and a few new items were added to the interview at each wave. The MADT and LSADT are comparable with regard to the design, implementation and data collection instruments with only minor differences that reflect the different age distributions in the two surveys. Data

collection in each survey wave was carried out at participants' homes. No exclusion criteria were used. If persons refused or were unable to participate in the face-to-face interview, a proxy respondent, usually a close relative, was sought. The response rates at the baseline surveys were 83 % in the MADT and 77 % in the LSADT [18, 19].

The respondents of the baseline LSADT were similar to non-responders in terms of age distribution, MZ:DZ ratio, and earlier hospitalizations in 1977–1994 [18]. Furthermore, the Danish participants are representative of the total Danish population of the same age as previous research in Denmark and Sweden demonstrated that twins are similar to the general population in terms of all-cause or cardiovascular mortality, fecundity, and, in contemporary twins with regard to school performance [22–28].

The Russian data come from the study of Stress, Aging, and Health in Russia (SAHR) that is a prospective population based cohort study of Moscow population aged 55 and older [29]. The study was jointly conducted by the State Research Center for Preventive Medicine (Moscow, Russian Federation), the Max Planck Institute for Demographic Research (Rostock, Germany) and Duke University (Durham, USA). The SAHR study participants were randomly selected from previous seven epidemiological cohorts, the Lipid Research Clinics (LRC) and MONICA cohorts designed in the mid-1970s–1990s. Since the epidemiological cohorts included the residents of Moscow before the mid-1980s, additional participants representing those who moved to Moscow after 1985 were identified from the Moscow Outpatient Clinics' registry. The SAHR baseline survey was conducted between December, 2006 and June, 2009 and included 1,800 participants. The final response rate was 66 %. Face-to-face interviews and extensive medical examinations were administered mainly at the hospital, only participants unable or reluctant to come to the hospital were interviewed at their own homes using the hospital protocol. A substantial part of the SAHR questionnaire was designed based on the data collection instrument used in the LSADT.

Sex- and age-specific mortality

The Human Mortality Database (HMD) was used to examine sex differences in all-cause death rates in Denmark and Russia by 5-year age group and sex in 2007 and 2008 [11]. These years were selected as they are the closest years, when the most SAHR data were collected. The data on mortality in Moscow in 2007–2008 were taken from the Russian Fertility and Mortality Database (RFMD) [30]. It is necessary to note that demographic data for Moscow from 2002 onwards may be problematic due to the population denominator overcount [31]. In addition, being a population with high proportions of migrants, Moscow is characterized by a substantial understatement of male mortality among the very old that is reflected in artificially low male–female mortality rate ratio at advances ages [32].

Health measures

The question about global self-rated health (SRH) asked participants to rate their health in general: How do you consider your health in general? In the Danish surveys possible response options were: excellent, good, acceptable, poor, and very poor, and in the SAHR: excellent, very good, good, fair, and poor. To investigate sex differences in the prevalence of poor general health and its age related trajectories the response options excellent, very good, good, and fair/acceptable were combined into the higher category, whereas the response options poor and very poor were collapsed into the lower category.

The assessment of physical functioning in the LSADT was based on self-reports of the activities participants were able to perform on the day of the interview. The instrument was previously validated in Denmark and described in details elsewhere [33]. In brief, it included all items from the Katz Index of Activities of Daily Living, as well as questions about more demanding activities, such as running, and questions about the ability to see and hear [34–36]. Based on factor analysis, the items dealing with ability to walk, run, climb stairs, and carry weights were used to create strength scale [33, 37]. It ranges from 1 to 4, being an average of the 11 items, with higher scores corresponding to higher levels of physical functioning. This scale has been shown to have high internal consistency (0.93) for both in-person and proxy interviews and to be moderately heritable.

Self-reported physical functioning in the SAHR was assessed using 10 items from physical function section of SF-36 [38, 39]. The participants were asked to evaluate how much on a usual day their health limits the performance of various activities ranging from bathing or dressing to moderate and vigorous activities, such as moving a table, running, lifting heavy objects, etc. There were three response options: 1—yes, limited a lot, 2—yes, limited a little, 3—no, not limited that reflect the presence and the degree of physical limitations. A standard procedure was used to calculate PF score ranging from 0, indicating complete disability, to 100, indicating full functioning [38, 39]. For comparison reasons the physical functioning scores in Denmark and Moscow were standardized by computing the z-score and producing a variable with mean 0 and standard deviation 1.

Additional comparison of physical functioning in the Danish and Moscow surveys was done on the item level asked similarly in the two studies. This included ability to carry a bag of groceries and to climb from one to another

flights of stairs in the LSADT and the ability to carry a bag of 5 kg and to climb one flight of stairs in the SAHR. The persons with full functionality on a specific question were defined as free of disability. In the Danish surveys the persons reporting that they were unable to perform the activity, have major or minor difficulty or needed assistance ('no, not able', 'yes, with major difficulty', 'yes, with minor difficulty', 'yes, with aids', or 'yes, with personal assistance') were considered as having disability. In the SAHR the individuals reporting major or minor limitations ('1—yes, limited a lot', '2—yes, limited a little') in carrying out an activity due to health problems were coded as being disabled.

Cognitive function was assessed using scores of immediate word recall test in Denmark and Moscow and the Mini-Mental State Exam (MMSE) in the LSADT and the SAHR. Respondents were asked to recall immediately a list of 12 nouns and the scores were computed as the total number of correctly recalled words. The MMSE is a 19-item standard neurological screen with scores ranging from 0 to 30 [40]. Higher scores of immediate recall tests and MMSE reflect better cognitive ability. Both the Danish and Russian versions of the MMSE questionnaire regarding orientation to place were modified according the suitability of these items to the geographic settings. Since the item "what is this building" was not asked in the SAHR baseline, the sum of 4 orientation items was multiplied by 1.25 to make it comparable to the 30-point standard MMSE score.

In both the Danish and Moscow surveys depression symptomatology was assessed using the depression section from the Cambridge Mental Disorders of the Elderly Examination (CAMDEX) [41]. Sixteen items reflecting affective and somatic depression symptomatology and identically asked in the Danish and Moscow surveys were summed to calculate total depression symptomatology scores [42]. Prior to calculating the scores, the items were transformed so that the higher is the value, the greater is the depression symptomatology of each item.

To facilitate the comparison of prevalence rates of poor self-reported health and physical disability items, the rates were standardized with respect to age by the direct method using the European population standard [43]. All data analyses were performed using Intercooled Stata 11.2 [44]. The Moscow data were weighted using post-stratification weights for age and education to bring the age-education composition of the sample to the general Russian population [29], the Danish data were unweighted. Chi square tests with sampling weights in the Moscow study population were used to examine sex differences and cross-country differences in the prevalence of poor self-rated health and physical disability. Two independent sample t tests with sampling weights in the Moscow study population were used to examine sex differences and cross-country differences in physical functioning, cognitive functioning, and depression symptomatology.

Results

All-cause sex- and age-specific mortality rates

Figure 1 illustrates that in 2007–2008 women had consistently lower death rates at all ages in Denmark, Russia, and Moscow, but the sex ratio was markedly lower in Denmark than in Russia and Moscow, especially at the younger ages. The Russian men aged 55–59, 60–64, and 65–69 years had about three times higher mortality rate compared with their same-age female counterparts, whereas in the same age range Danish men had about 1.5 times higher mortality rate than Danish women (Supplementary Table 1). Although the sex differentials in all-cause mortality were slightly smaller in Moscow than in Russia, the sex ratio in Moscow was still approximately double that in Denmark at middle and young-old ages. The age trajectories of the sex ratio were country-specific. In Denmark, the sex ratio continuously declined with age from 1.53 at age 55–59 to 1.44 at 80–84 years, and to 1.22 at age 85+. In Russia and Moscow, the sex ratios were highest among persons 55–59 (2.89 in Russia and 2.63 in Moscow) and 60–64 years old and afterwards declined rapidly to 1.36 and 1.18 at age 85+ in Russia and Moscow, respectively. Denmark–Russia and Denmark–Moscow differences in age-specific mortality rates were larger among men than among women (Supplementary Table 1).

Self-rated health

There was almost no sex difference in the prevalence of poor SRH in Denmark, whereas it was higher among female Muscovites than among their male counterparts (Fig. 2). The sex difference in the age-standardized prevalence rates (ASPRs) of poor SRH was significant in favor of men in both settings (Supplementary Table 2). In addition, Danes had significantly lower ASPR of poor SRH compared with their same-sex Muscovite counterparts. The percentage of persons with poor SRH increased with advancing age, but there was no apparent sex-specific pattern in any study.

Physical functioning

Men reported significantly better physical functioning compared with their female counterparts in both study populations and the sex gap was larger among Muscovites than among Danes (Fig. 3). Physical functioning declined

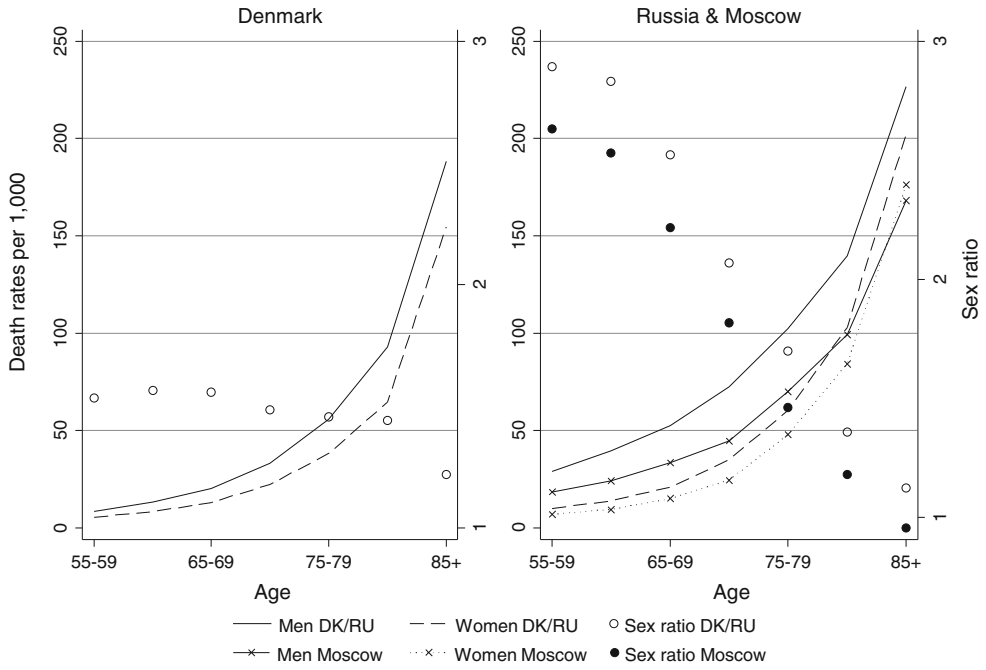

Fig. 1 Age- and sex-specific death rates and sex ratios in Denmark, Russia, and Moscow in 2007–2008

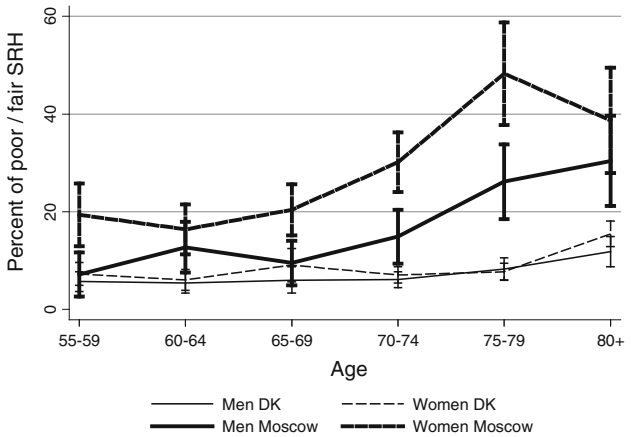

Fig. 2 Prevalence of very poor and poor self-rated health

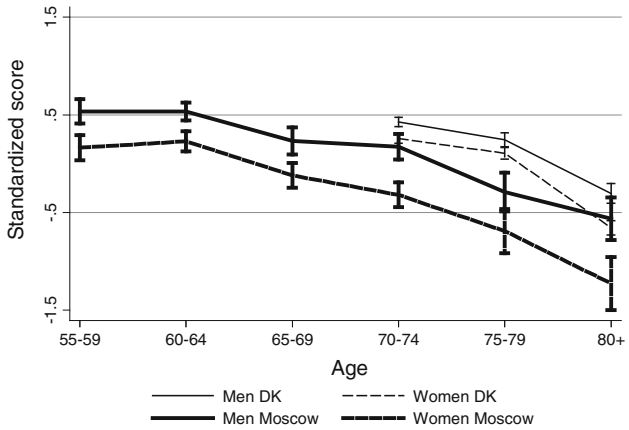

Fig. 3 Standardized reported physical function

and the sex gap increased with advanced age in Denmark and Moscow. Cross-country comparison showed that within each sex Danes had substantially higher levels of physical functioning than their Muscovite counterparts (Supplementary Table 3).

The percentage of persons unable to carry a bag of groceries (Fig. 4) and unable to climb one flight of stairs (Fig. 5) was significantly higher among women than among men in Denmark and Moscow in most age groups (Supplementary Table 2). Remarkably, about 40 % of Russian women aged 55–59 to 65–69 years were unable to carry a bag of groceries in comparison to about 30 % of Danish women aged 70–74 years. The ASPRs of disability on both items were significantly higher among women than men in Denmark and Moscow. Danes had significantly lower ASPRs of disability on carrying a bag of groceries compared with their same-sex Muscovites. Danes tended to have lower ASPRs also on climbing one flight of stairs, but the cross-country difference was significant among women only. Disability levels on both items of physical functioning increased with advanced age, but age trajectories were similar in men and women.

Cognitive function

The Danish women had significantly better performance on the immediate recall test compared with men in all age groups (Fig. 6), except for 65–69 year old persons.

However, the magnitude of sex difference was very small corresponding approximately to the recall of one word. In Moscow, women tended to have higher immediate recall scores at every age. The performance on the immediate recall test declined with advanced age and the trajectories were similar in men and women in Denmark and Moscow. Within sex comparison indicated significantly higher immediate recall scores among Muscovites than among Danish respondents in both genders.

MMSE scores were similar among men and women in Denmark and Moscow (Fig. 7). Although Danish men tended to have higher scores than Danish women and the female Muscovites tended to have higher scores compared with male Muscovites, the sex differences was not statistically significant in most age groups (Supplementary Table 3). The MMSE score declined with advanced age, but the decline was slower at younger ages. The Fig. 6 also showed that Danish men scored higher than Muscovite men, but there was no statistically significant difference in the female populations. Noteworthy, the Moscow participants at ages 55–59 scored similarly to those in their early 70s and also lower than the Danish respondents at ages 70–74 years.

Depression symptomatology

Total depression scores were significantly higher among women than among men at all ages in Denmark and Moscow (Fig. 8). The sex gap was smaller and the depression symptomatology levels within each sex were significantly lower among Danes than among Muscovites (Supplementary Table 3). In general, the depression symptomatology increased with advancing age in Danish and Moscow surveys, but there was no sex-specific pattern in age trajectories in either study.

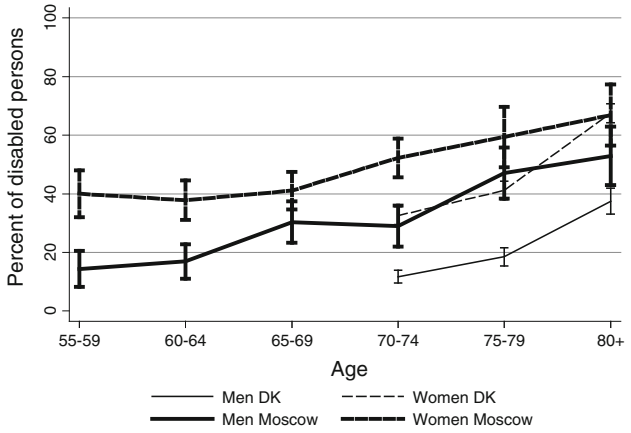

Fig. 4 Disability on carrying a bag of groceries

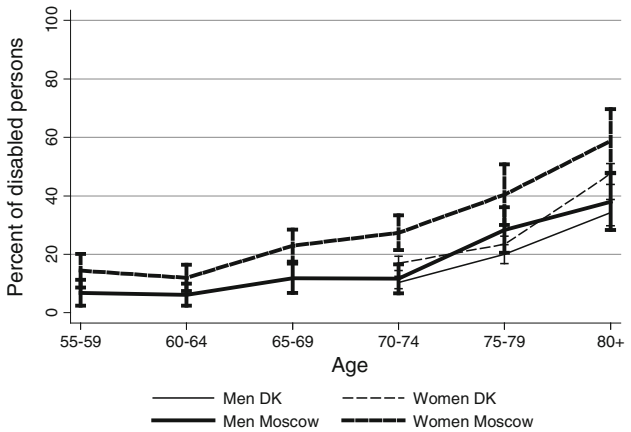

Fig. 5 Disability on climbing one flight of stairs

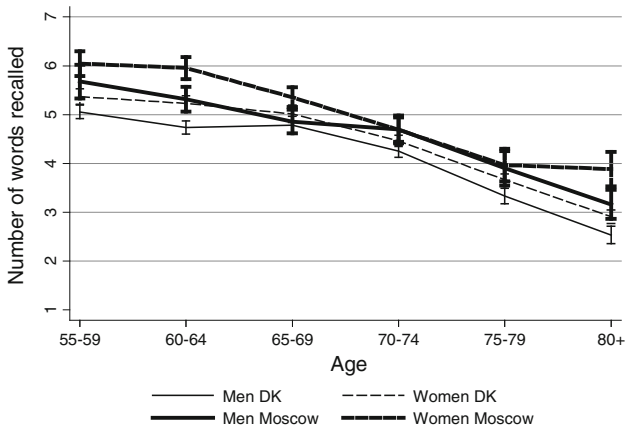

Fig. 6 Immediate recall

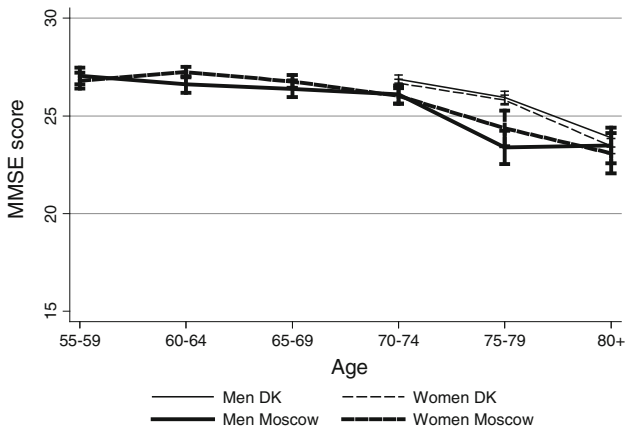

Fig. 7 Mini-Mental State Exam

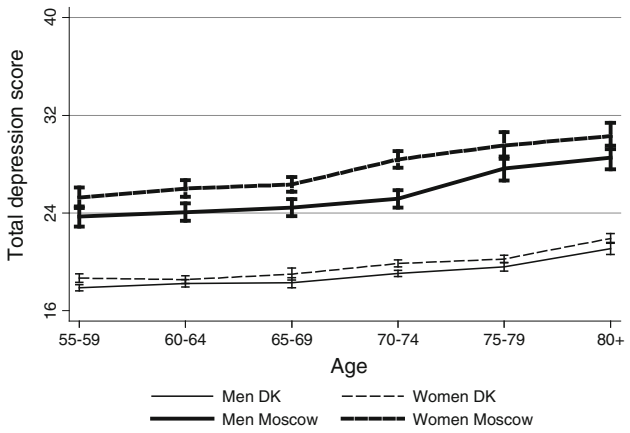

Fig. 8 Total depression score

Discussion

The present study revealed consistent female advantage in mortality at all ages and male advantage in avoiding physical disability and depression symptomatology at ages 55–89 years in Denmark and Moscow. Despite 2.5–3 times higher mortality at ages 55–69 years, the Moscow men were healthier with regard to depression symptomatology and physical functioning and tended to rate their general health better than their female counterparts. Only on cognitive tests the male Muscovites performed similarly to or worse than female Muscovites. In Denmark, women tended to have higher immediate recall score compared with men, although the sex gap was small and likely to be unimportant in daily functioning. The MMSE levels were also similar among Danish men and women. These findings add to the existing evidence that in some aspects of health women are more disadvantaged than men in many countries regardless of their economic progress and cultures [3, 4, 6, 45].

Why middle-aged and young-old Moscow men, such healthy in terms of physical functioning, depression symptomatology, and general health had about 2.5 times higher mortality compared with the same-aged Moscow women?

The first potential explanation that one would deem likely is the structural components of mortality in Russia. In Russia, mortality from external causes, which depends on aging much less than mortality from other (natural) causes, is especially high and is much higher among men than among women [12, 46]. Thus, one might think that a strong male–female health-survival paradox at ages 55–69 in Russia could be attributed to the male excess mortality due to external causes of death. It appears, however, that the ratio of the male–female mortality rates for natural causes (all causes but external) at ages 55–69 was nearly the same as the same ratio for all causes combined, 2.5 versus 2.6 in 2007–2008, respectively (data no shown), suggesting that for most diseases the male mortality excess in Russia is very high.

A more important contribution to the explanation of such a pronounced male–female health survival paradox in Russia may have sex differences in the prevalence of various diseases and pathological conditions. International evidence shows that women experience greater number of comorbidities that are not lethal but disabling, whereas men experience more life-threatening conditions [3, 6, 47]. Epidemiological studies found that the age-specific incidence of myocardial infarction and stroke is higher among men than among women [9, 48], although some studies showed that the sex difference in the incidence of stroke and prevalence of hypertension diminishes or even reverses at advanced ages [49, 50].

Results of prior Russian studies generally agree with the disease-composition explanation. For example, the recent study on the methabolic syndrome demonstrated that while Muscovite women experience much higher prevalence of obesity, men experience much higher incidence of myocardial infarction, higher prevalence of hypertension, and hyperglycemia [51]. It was also reported that Russian men have substantially better general and phychological health than Russian women, they have much higher levels of smoking and alcohol drinking and higher incidence of related cancers [52–55]. It suggests that the sex-specific distribution of more fatal and less fatal health conditions may play an important role in explaining a strong male–female health-survival paradox in Russia.

Another issue to consider is the differences in mortality selection in the Russian and Danish populations. The sex gap in the force of selection is much greater in Russia than in Denmark. According to the HMD, probabilities of dying under age 55 in 2007–2008 were: 8 and 5 % for Danish men and women, respectively, and 32 and 12 % for Russian men and women, respectively. Respective probabilities of dying between ages 55 and 70 were: 45 and 20 % in Russia versus 18 and 12 % in Denmark. The apparent inter-country difference in selection may be largely attributed to especially pronounce gender difference in health behaviors in Russia [54, 55]. In 2003, the sex gap in smoking prevalence at ages 18 years and older was 47.8 % (62.6 % among men vs. 14.8 % among women) in Russia, whereas it was 6 % (31 vs. 25 % among women) in Denmark in 2006 [56]. Based on the LRC data collected in 1975–1977 in Moscow and Saint-Petersburg, the probability of surviving from age 40 to 70 years was about 70 % among non-smokers versus about 45 % among heavy smokers (16–20 cigarettes per day) [57]. Greater sex differences in lifestyle behavior in Russia and mortality selection especially among middle-aged Russian men and old-aged women can partially explain why the male–

female health-survival paradox is stronger in Moscow than in Denmark.

Differences in economic situations and social support systems may also explain greater paradoxical sex differences in mortality and health between Denmark and Russia. The transition from planned to market economy, social disruption and weakening of social support systems in Russia over the 1990s had unequal effects on male and female mortality in Russia [58]. Although the relative increases in male and female mortality rates were similar, the absolute change in the number of excess deaths and losses in LE and the absolute levels of mortality rates were much greater among men than among women [58, 59]. Researchers suggested that the Russian men responded to psychosocial stress caused by the economic crisis in 1990s by elevated mortality rates, whereas the Russian women responded by worsened health [16]. The division of gender roles and responsibilities can underlie sex differential response to stress [60]. In Russia, the distribution of social roles is more traditional with mainly men being breadwinners, which can be a hard role in a situation of economic and social disruption, and can expose the men to psychosocial stress at a higher degree compared with their female counterparts [14]. The Russian women were limited in the choice of jobs by social norms and regulations based on perceived dangers to reproductive health, most of which had no scientific basis and served primarily to keep women in lower status and least attractive jobs [16]. As women were expected to work and to care about family and parents, they experienced a double burden that might contribute to their worsening health. Contrary to Russia, over many decades Denmark has adopted gender—equality oriented policies with more women responsible for family income and more men carrying of family and household.

The present study utilized cross-sectional survey data that potentially inherit selective nature of the study samples. A previous study in Denmark found slight overrepresentation of hospitalized women and women using prescription medications in the surveys, suggesting that selection bias in surveys could contribute to the explanation of the health–survival paradox, but its contribution was likely to be small [18, 61]. If Muscovites participating in the study were healthier than or reported to be healthier than non-respondents and this difference were more pronounced among men than among women, the sex differences in health in Moscow population would be different.

Our findings indicated that about 40 % of the 55–64 years old females Muscovites were disabled on carrying a bag of groceries and had the levels of MMSE scores close to that of those in their early 70 s. When the disability was defined as having only substantial limitations ('yes, limited a lot'), the percentage of the Moscow women unable to carry a bag of groceries dropped to about 10 %. However, the differences in response options for items of physical functioning in the LSADT questionnaire hampered identification of the individuals slightly limited in their activities on the same scale as in the Moscow survey. Therefore, only those individuals who had no limitations to perform these activities were considered as free of disability. A possible explanation for low MMSE scores among SAHR participants aged 55–64 years is that the MMSE instrument may not be sensitive to detect cognitive impairments at younger ages. Nevertheless, a high prevalence of physical disability and low MMSE scores among young Muscovites are worrisome as such and urge further investigation.

One key concern in cross-country comparison studies is the comparability of available data. Significant part of the Russian questionnaire was designed based on the data collection instrument used in the LSADT enabling comparison of health domains on the same scale. Although some part of inter-country differences in health can be due to methodological differences between the studies, the intra-country comparison of sex differences in health is less sensitive to the differences in data collection instruments and response patterns.

Some cross-country differences in health can be due to differences response rates and inclusion criteria between Danish and Moscow surveys. The response rates were higher in the MADT (83.1 %) and LSADT (77 %) than in the SAHR (66 %). The LSADT included also proxy respondents for physical functioning, whereas very sick individuals unable to participate in the interview either at the clinic or at their own homes were excluded from the Moscow survey. The inclusion of healthier participants in the SAHR could attenuate cross-country differences in selected health domains. The additional analysis of physical functioning without proxy responses in the LSADT yielded similar results, although the actual level of physical functioning among self-respondents was higher (results not shown). Since response rates tended to be higher among women and highly educated individuals in the SAHR, the under-represented groups were moderately over-sampled and appropriate weights were used to facilitate international comparisons [29]. Additional analysis of the Moscow data without weights showed similar sex differences in and age-related trends of health measures as with weighted data (results not shown).

The present study showed that the directions of sex differences in some health measures previously found by international comparison studies are quite uniform and can be generalized to Moscow, which is very different from Denmark with respect to demographic trends, health and social systems, and culture. As expected, the female disadvantage in physical functioning and depression symptomatology was indicated in Denmark and Moscow. There

was a tendency toward better self-reported health among men, contrary to what could be expected based on sex gap in mortality. The direction and size of sex gap in cognitive function differed across measures of cognitive functioning and geographic settings.

In Moscow and Denmark, the group with the generally worst health profile was Moscovite females. Still Muscovite males had more than twice higher mortality at ages 55–69 years compared to Muscovite women. It points out that the male–female health-survival paradox is very pronounced in Moscow and suggests a strong sex-specific disconnect between health indicators and mortality, especially among middle-aged and younger elderly in Moscow.

Finally, considering low MMSE scores and high disability levels on some physical functioning items, future research should focus on identifying factors that contribute to ill health among middle-aged Muscovites. Based on such research findings appropriate strategies should be designed to prevent disability at such young ages and improve quality of life at older ages in Russia.

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Conflict of interest The authors declare that they have no conflict of interest.

Ethical standard The study involves secondary data analysis existing survey data. The LSADT and MADT have been through review and are approved by the ethical committee assigned through the Danish National Committee on Biomedical Research and the Danish Data Protection Agency. The SAHR was approved by the Ethical Committee of the State Research Centre for Preventive Medicine, Moscow, Russia and the Institutional Review Board at Duke University, Durham, USA.

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