Widowhood and cognition among older women in India: New insights on widowhood duration and mediators

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ABSTRACT

Background: Widowhood, a marital status that disproportionately affects older women, has been associated with poorer health compared to married individuals. However, relatively little is known about the association between widowhood in later-life and cognitive health in low- and middle-income countries.
Methods: To address this research gap, we used data from the Longitudinal Aging Study in India (2017–19) to investigate the widowhood disparity in cognitive health among mid-aged and older women in India, including how this relationship varies by the duration of widowhood. We further examined the extent to which economic, social, and health conditions mediate this association.
Results: Cognition scores for widowed women were on average lower by almost 0.1 standard deviations compared to married women. Overall, this disparity increased with widowhood duration, with non-linearities in this association. The disparity in cognition scores increased with widowhood duration up to twenty years but did not increase further among those with longer widowhood duration. Worse physical and mental health were found to mediate almost thirty percent of the total association between widowhood and cognition. These mediators were most useful in explaining the association between lower cognition and widowhood among women who experienced widowhood for ten years or longer.
Conclusion: The study highlights the significant disadvantage in cognitive functioning among older widowed women in India. The study also provides evidence on potential mediators, suggesting differential effects of mediators at different stages of widowhood.

1. Introduction

While it is well established that older age is a significant risk factor for cognitive decline (Brookmeyer et al., 2007), there is also emerging research on how widowhood, more common among older women, may be associated with worse cognitive function. A systematic review of 15 observational studies around the world found a higher risk of developing dementia (i.e., cognitive impairment severe enough to cause loss of independence in daily function) among widowed individuals compared to their married counterparts (Sommerlad et al., 2018). Emerging biomarker research has also found independent and interactive relationships among widowhood, β-amyloid levels (an abnormal brain

protein associated with Alzheimer's disease), and cognitive decline compared to married participants (Biddle et al., 2020). However, few studies have examined the relationship between widowhood and cognition in the context of India, which has one of the largest widowed populations, of predominantly women, in the world.

India is a rapidly changing country undergoing a significant demographic transition due to longer life expectancies and lower fertility rates (The World Bank, 2021; United Nations, 2019). India has the second largest oldest population in the world, and the population of those aged 60 years or older is expected to nearly double to 19% of the total population by the year 2050 (United Nations, 2019). Women have longer life expectancy in India and will make up a larger share of the

older population, compared to men (The World Bank, 2021; United Nations, 2019). The share of non-married older individuals is also much higher among women than men, with widows making up the largest share of unmarried women in India (Census of India, 2011). Gender, marital status, and differences in social position between men and women are important for understanding demographic changes since older populations are disproportionately female and widowed (Carr & Bodnar-Deren, 2009).

Hence, in this paper we examined the widowhood disparity in cognitive function among older women in India, using novel data from the baseline wave of India's first nationally representative aging survey, the Longitudinal Aging Study in India (2017–19) (henceforth LASI). We addressed three major research questions. First, do widowed women in India have worse cognition than married women, and what is the extent of this disparity? Second, how does this cognition disparity vary by widowhood duration? Third, what are the pathways/mediators that link widowhood – both status and duration – to cognitive health? The findings speak to the unique challenges faced by older widowed women in lower-income settings regarding cognitive health and examine potential pathways which could inform social policy for this vulnerable sub-population.

Previous Empirical Studies: Widowhood and Cognition. Prior studies have documented a negative relationship between widowhood and cognitive function among older adults, albeit most of these findings are from high-income countries (Aartsen et al., 2005; Atalay & Staneva, 2020; Gerritsen et al., 2017; Rosnick et al., 2010; Vable et al., 2015; Vidarsdottir et al., 2014; Zhao et al., 2021). Shin et al. (2018), using data from the Health and Retirement Study (henceforth HRS), documented that widowhood was significantly associated with cognitive decline among older adults in the United States, and found a linear relationship between time since spousal loss and cognitive decline. Liu, Umberson, and Xu (2020), also drawing upon the HRS data, found that unmarried groups had higher odds of developing dementia. Wörn et al. (2020) interestingly found evidence for only a temporary decline in cognitive functioning post widowhood among women but no such effect among men in Amsterdam. Since the levels of cognitive health, as well as the experiences of widowhood, could vary by the level of economic development and the socio-cultural context, it is worth noting that similar negative associations between widowhood and cognition have been found in East Asian countries as well, like China (Zhang et al., 2019), Taiwan (L.-Y. Fan et al., 2015) and South Korea (Lyu et al., 2019). Our paper is most closely related to the work by Perkins et al. (2016) on older adults aged 60 and above, using data from seven states of India. They examined multiple health outcomes, including cognition as measured by the ten-word immediate recall score, for which they found a negative relationship among widows but not among widowers. They also looked at the duration of widowhood and found that recently widowed women and long-term widows were more likely to have worse health (including cognitive function) though not women who were widowed for 5–9 years. Our paper moves beyond Perkins et al. (2016) in important ways. We used nationally representative data, including middle-aged and older women (aged 45 and above), and a more comprehensive summary measure of cognition. More importantly, we investigated multiple mediating mechanisms, which is the most significant contribution of our paper. Both the nature of mechanisms and the extent to which they mediate the association between widowhood and lower cognitive health in old age might be different across various economic and cultural settings. For example, increased risk of economic hardship after widowhood is often suggested to be a key mechanism leading to poor health for the widowed in the western literature (Liu, Umberson, & Xu, 2020). This may be more relevant in India due to fewer economic resources in general among the households, exacerbated by limited government support. To the best of our knowledge, no prior research on later-life widowhood in India has examined and compared these detailed mechanisms, and how their significance might vary with the duration of widowhood.

Theoretical Background: Widowhood, Marriage, and Health. Two different theoretical models have been developed to explain why married individuals tend to have better health than their unmarried counterparts, including widowed individuals. The first is the "marital resource model", which posits that marriage provides unique social, psychological, and economic resources that cannot be obtained from other types of relationships (such as cohabitation) and in turn promote physical health and longevity (Waite & Gallagher, 2000). In terms of economic resources, marriage may lead to an increase in economic resources through specialization, economies of scale, and the pooling of wealth (Becker, 1981). Economic resources may enhance health by improving nutrition, providing care in the event of illness, and allowing the purchase of medical care or other health-enhancing resources (Waite & Gallagher, 2000). In terms of social and psychological resources, a marital relationship increases access to social support (i.e., providing love, advice, and care), social integration (i.e., feeling connected to others), and social control of health behaviors (i.e., the deliberate efforts of others to control one's health and health behaviors) – all factors that may promote health and well-being (Liu & Umberson, 2008).

Another theory is "the stress model", which considers how a disruption in marital status, such as becoming widowed, adds additional emotional and economic stress leading to unhealthy behaviors and other worse health outcomes (Williams & Umberson, 2004). In contrast to the marital resource model which attributes marital benefits to the positive effects experienced by the married, the stress model suggests that the strains of marital dissolution are the primary factor responsible for undermining the health of the divorced and widowed which, in turn, leads to marital status differences in health (Williams & Umberson, 2004). The process of marital dissolutions through either divorce or widowhood is stressful, although the end of caregiving after the death of a spouse may also signify a relief from a chronically-stressful caregiving role (Keene & Prokos, 2008). The elevated stress from marital dissolutions can cause detrimental changes and emotional and behavioral problems, such as feeling depressed, smoking, and drinking (Williams & Umberson, 2004). These emotional and behavioral problems may in turn damage cognitive function and accelerate cognitive decline in later life (Hayes et al., 2016; Swan & Lessov-Schlaggar, 2007).

Additionally, life-course scholars argue that advantages or disadvantages may have cumulative effects on an individual's outcomes over life course stages (Dannefer, 2003). This "cumulative-advantage/disadvantage" of being married or widowed may continue to play a role in cognitive health over time. For example, the stress from the death of a spouse may have cumulative effects on one's cognitive health as one ages because of the declining immune function and increasing frailty that typically develops in aging individuals. Moreover, the resources accrued from a marriage may also have cumulative effects on health as the health advantages of marriage tend to increase with the duration of marriage (Waite & Gallagher, 2000). Taken together, the marital resource model and the stress model, along with cumulative disadvantage of being widowed, point to economic, social, and health factors that may lead to widowhood disparity in cognition, as we will discuss next in the context of India.

Factors related to cognition and widowhood in India. Strong social and economic gradients have been found in cognitive function in India, such as gender, marital status, education, caste, and socio-economic status (Oksuzyan et al., 2018; Onur & Velamuri, 2016; Singh et al., 2018). Moreover, region of residence in India may play a large role and research has shown regional differences for gender and cognition (Lee et al., 2014; Onur & Velamuri, 2016; Singh et al., 2018). The experiences of widowhood vary by cultural context. Historically, widowhood status among women in India has been fraught with uncertainty and risks pertaining to survival (e.g., widow immolation post husband's demise, colloquially known as *sati*, was practiced for centuries), and continues to be associated with neglect (M. A. Chen, 1998). As per the 2011 Census of India, there were 36.47 million widowed women aged 45 or older, comprising 29 percent of the total number of women in this age group.
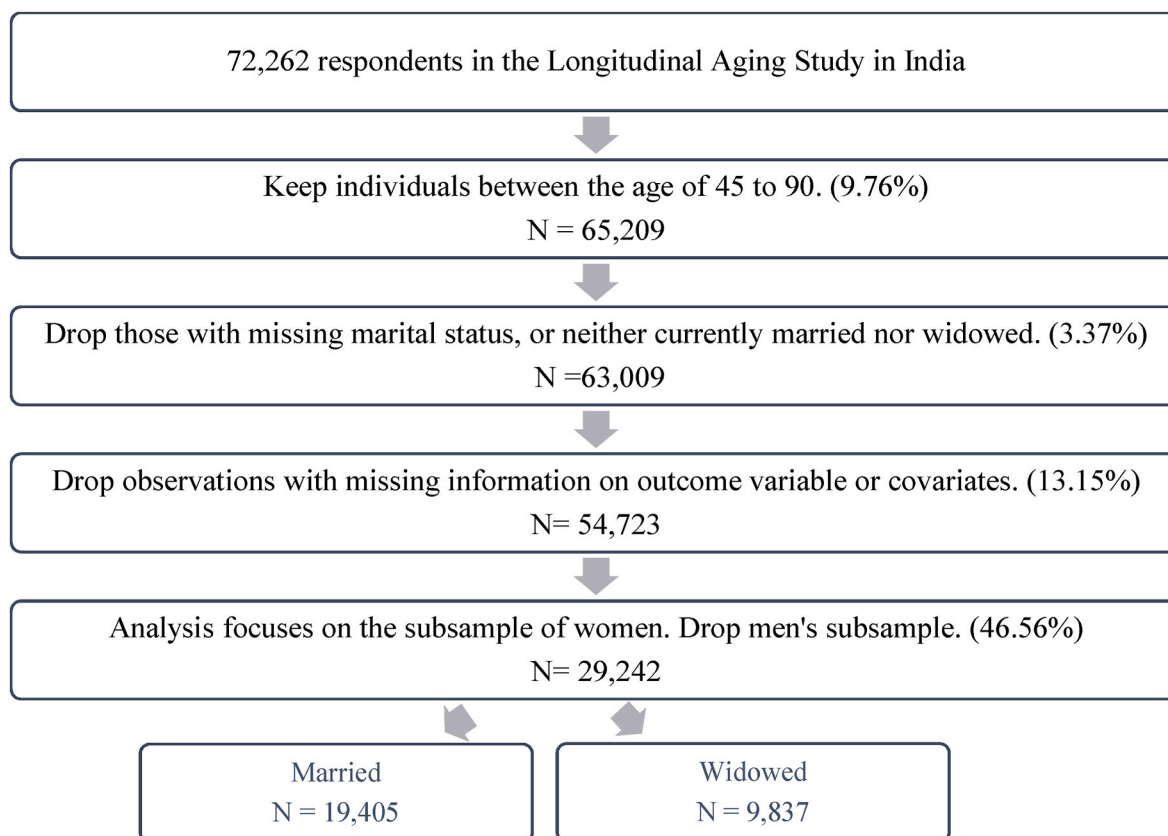
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│      72,262 respondents in the Longitudinal Aging Study in India      │
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┌─────────────────────────────────────────────────────────────────────┐
│       Keep individuals between the age of 45 to 90. (9.76%)           │
│                          N = 65,209                                    │
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                                   ▼
┌─────────────────────────────────────────────────────────────────────┐
│  Drop those with missing marital status, or neither currently         │
│  married nor widowed. (3.37%)                                          │
│                          N =63,009                                     │
└─────────────────────────────────────────────────────────────────────┘
                                   ▼
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│  Drop observations with missing information on outcome variable or     │
│  covariates. (13.15%)                                                  │
│                          N= 54,723                                     │
└─────────────────────────────────────────────────────────────────────┘
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│  Analysis focuses on the subsample of women. Drop men's subsample.    │
│  (46.56%)                                                              │
│                          N= 29,242                                     │
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              ▼                                        ▼
┌──────────────────────────┐            ┌──────────────────────────┐
│         Married          │            │         Widowed          │
│       N = 19,405         │            │        N = 9,837         │
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Fig. 1. Construction of the analysis sample.

The sweeping nature and magnitude of the overall female disadvantage in the Indian context is aptly captured by the findings of (Anderson & Ray, 2012, 2019), who showed the age distribution of "missing women" (insufficient number of women compared to the expected number of women as measured by divergence from natural sex-ratios) in India, the majority of whom were found at older ages. There was regional variation in the estimates of "missing women", which the authors found to be the highest in the northern states and lowest in southern states. They hypothesized non-communicable diseases and widowhood to be the main causes for the regional disparities of missing women. These patterns should be considered when using household-level data which would not include these "missing women".

Economic and health disadvantages of widowhood in India. There has been some quantitative examination of economic and health outcomes for widowed women in India. As per the analysis by Drèze and Srinivasan (1997), households with widowed women did not have significantly lower average per capita household consumption compared to households without widowed women in rural India. However, they also found that widowed women were more likely to live in smaller households, which can be at a disadvantage due to diseconomies of scale,[1] along with emphasizing that individual-level disparities faced by widowed members in the intra-household allocation of consumption would not be captured by household-level measures. Analysis by Jensen (2005) found that widows in India had lower economic well-being, body mass index (henceforth BMI), and self-reported health, and these associations varied by caste – widowed women in upper-caste households were found to be better off economically (as measured by per capita expenditure) compared to widows belonging to other castes but this advantage did not hold when examining measures of health. However, the sample only consisted of women aged 45–49. Widows in India have been found to have worse mobility (Sengupta & Agree, 2003), lower self-rated health (Sudha et al., 2006), lower likelihood of healthcare utilization (Sreerupa & Rajan, 2010), and higher prevalence of morbidity (Agrawal & Keshri, 2014). Lloyd-Sherlock et al. (2015) conducted a multi-country examination of later-life widowhood and wellbeing, which included India, and found widowhood to be positively associated with food scarcity, depression, and being underweight, and negatively associated with self-rated health. Most of this prior research recommends that the mechanisms linking widowhood and worse health outcomes should be further examined.

Social disadvantages of widowhood in India. Female widowhood experiences specific to the Indian context are the discriminatory practices that lead to their vulnerable position in society, fraught economic conditions, and worse health outcomes. These include taboos on remarriage (which differs for men and varies by religion) and expectations of a retreat from regular life – circumstances best described by M. A. Chen and Bhaduri (2000) as "perpetual mourning". There are differences in the extent to which these restrictions are imposed – with greater adherence among Hindus and historically non-disadvantaged caste groups ("upper castes"), as discussed by M. Chen and Drèze (1992). They also discussed the differences between widowhood ratios by region and the stressors on widows' health, albeit only in north India. Kadoya and Yin (2015) also found that discrimination against widows does not hold across the country, but there are regional differences.

Previous studies have suggested that social factors (e.g., co-residence with children, visiting friends), economic factors (Kung, 2020; Z. Fan et al., 2021), and health (e.g., depression (Bunce et al., 2014; Chodosh et al., 2007; Crocco et al., 2010), being undernourished (Estrella-Castillo & Gómez-de-Regil, 2019; Selvamani & Singh, 2018), poor self-reported health (Small et al., 2011)) may accumulate over the life course to shape
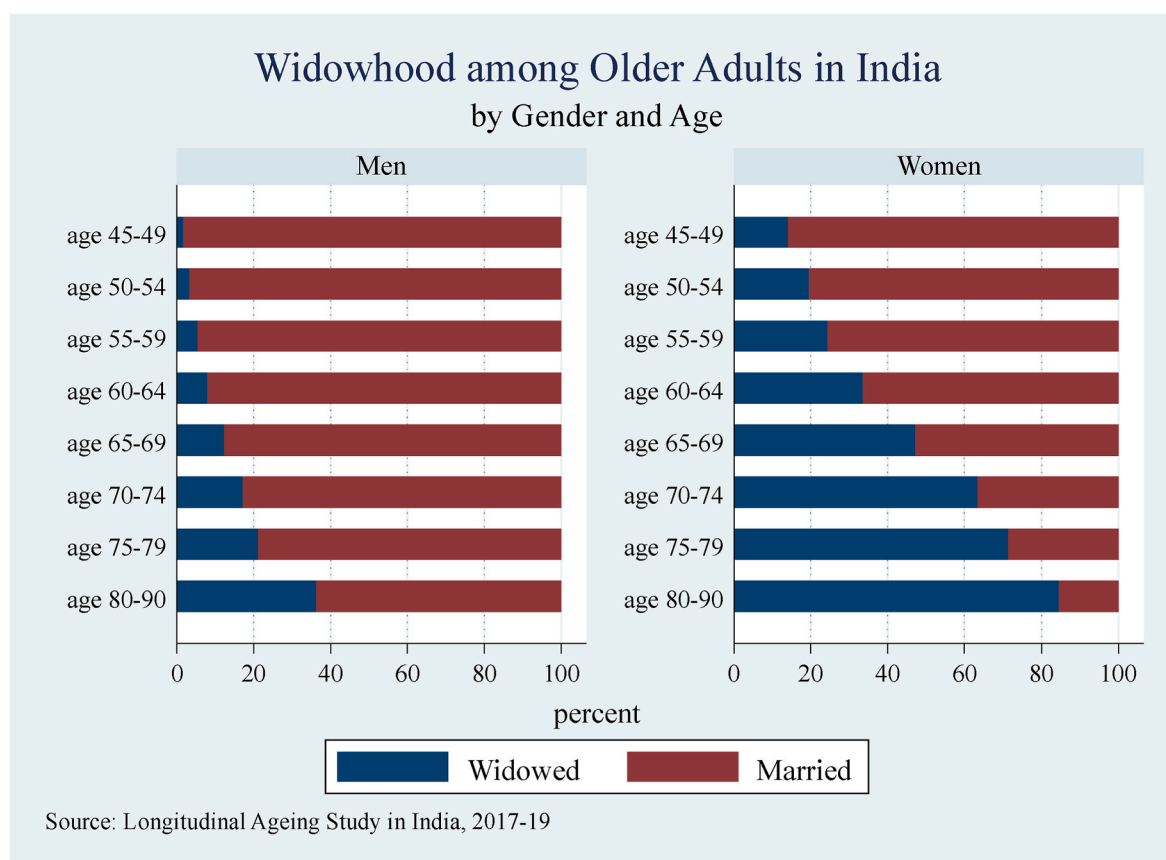
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[1] Diseconomies of scale within a smaller household, that is higher per capita costs, could lead to lower per capita consumption compared to a large household due to fewer avenues for task specialization, and fewer shared household public goods (Nelson, 1988).

Widowhood among Older Adults in India
by Gender and Age

Fig. 2. Prevalence of widowhood by age and gender among adults aged 45–90 in India.
Notes: divorced or separated, deserted, living-in or never married not included in the sample.

cognitive health. Therefore, we expect that these social, economic, and health disadvantages of the widowed relative to their married peers in India may contribute to cognitive disparity over time. Informed by the findings as well as the limitations of the literature on widowhood and health among older women in India, we formulated and tested the following hypothesis:

Hypothesis 1. Older widowed women in India have worse cognition than older married women.

Hypothesis 2. The widowhood disparity in cognition tends to increase with the duration of widowhood.

Hypothesis 3. The widowhood disparity in cognition is partially explained by economic, social, and health factors.

2. Data and methods

2.1. Data

This study used data from the baseline (first) wave of the Longitudinal Aging Study in India (2017–19). LASI is the first nationally representative survey of the health, economic, and social wellbeing of the Indian population aged 45 and older (Perianayagam et al., 2022). The study sample is representative of each of the Indian States and Union Territories and includes an over-sample of individuals over the age of 60. It is part of an international network of aging studies around the world, including the HRS from the United States. Compared to studies used in prior literature on the relationship between widowhood and health in India, LASI data provided us with a larger sample size along with more detailed information on economic, social, and health variables and a more comprehensive measure of cognition.

Analysis Sample. Our analysis sample comprised of women aged 45–90 years, for whom information was available for the outcome variable and all covariates. We dropped individuals younger than 45 since LASI's sampling strategy interviews individuals in the household aged 45 and older, and their spouses regardless of age. Since husbands tend to be older than wives in this context, almost all individuals under the age of 45 are female spouses, leaving no comparison group of widows for this age cohort. We dropped individuals aged older than 90 to mitigate concerns arising due to mortality bias. Individuals who reported to be divorced or separated, deserted, in a live-in relationship, or never married were not included in the analysis sample since these constituted a small proportion of the overall sample and are outliers in terms of the cultural norms in India where marriage is almost universal. We focused our analysis on women due to much higher rates of widowhood among this group compared to men. Our final analytical sample comprised of 29,242 older women. Fig. 1 shows the flow diagram outlining the construction of our analysis sample.

2.2. Variables

Dependent Variable. The outcome variable of interest was cognition. We constructed a summary cognition score by adding up scores on the following tests – orientation to time, orientation to place, average 10-word recall (immediate and delayed), animal naming, object naming, backward count from 20, serial 7s, computation, and executive function (as measured by close-your-eyes and paper folding tasks, and sentence writing).[2] Most of these cognition tests have been administered in other

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[2] We also constructed an alternative index using principal component analysis (PCA) to assess the robustness of our results.

Table 1
Summary statistics by marital status among older women in India.

	Widow (N = 9837)		Married (N = 19,405)		
	Mean	SD	Mean	SD	Difference
Cognition summary Z-score [-3.42, 5.35]	−0.31	0.93	0.06	0.93	−0.37***
Age [45, 90]	65.75	10.32	56.37	8.55	9.38***
Any school {0,1}	0.26	0.44	0.38	0.48	−0.12***
Height [102.4, 190.6]	148.42	6.69	150.51	6.26	−2.09***
Religion: Hindu {0,1}	0.83	0.38	0.82	0.38	0.01
Religion: Muslim {0,1}	0.11	0.31	0.12	0.32	−0.01
Religion: Other religions {0,1}	0.07	0.25	0.06	0.24	0.01
Caste: Non disadvantaged {0,1}	0.25	0.43	0.27	0.44	−0.02***
Caste: Other backward castes {0,1}	0.44	0.50	0.45	0.50	−0.01
Caste: Scheduled caste {0,1}	0.22	0.41	0.19	0.40	0.03***
Caste: Scheduled Tribe {0,1}	0.09	0.29	0.09	0.28	0
Rural {0,1}	0.69	0.46	0.72	0.45	−0.03***
Per capita annual household consumption [300, 14482676]	48,977.24	86,623.83	49,994.04	157,791.96	−1016.80***
Pucca house {0,1}	0.49	0.50	0.55	0.50	−0.06***
Ration card: BPL/*Antyodaya* {0,1}	0.60	0.49	0.52	0.50	0.02***
CESD[#] [0, 30]	9.61	4.45	8.71	4.04	0.90***
Underweight[##] {0,1}	0.26	0.44	0.17	0.38	0.09***
Self-reported poor health {0,1}	0.49	0.50	0.39	0.49	0.10***
Any co-residing children {0,1}	0.69	0.46	0.70	0.46	−0.01
Share most personal matters with at least one person {0,1}	0.87	0.33	0.95	0.22	0.08***
Have any friends {0,1}	0.22	0.41	0.25	0.43	−0.03***
Visit relatives/friends at least once a month {0,1}	0.40	0.49	0.45	0.50	−0.05***
Attend religious functions/events at least once a month {0,1}	0.21	0.41	0.25	0.43	−0.04***
Widowhood duration (years) [0, 60]	14.68	11.64	0	0	n.a.
Widowhood duration (% of categories)					
0–10 years	43.5				
10–20 years	30.5				
20+ years	26				

Data source: Longitudinal Ageing Study in India, 2017–19. *Notes.* Sample consists of women aged 45–90, who do not have missing information on any of the variables used. [#]Center for Epidemiologic Studies Depression Scale. [##]Defined as BMI <18.5 kg/m2. Individual-level analysis weights were used to obtain nationally representative estimates. ***p < 0.01, **p < 0.05, *p < 0.1.

aging surveys such as the HRS (Ofstedal et al., 2005). The combined score was converted to a z-score within the analysis sample for ease of interpretation.

Widowhood. LASI asked respondents their current marital status, with the following options: currently married, widowed, divorced, separated, deserted, live-in-relationship, or never married. Only three percent of respondents reported being either divorced, separated, deserted, live-in-relationship, or never married – they were dropped from the analysis given the focus on widowhood in this study. Respondents were further asked how many years and months ago they became widowed, if applicable. Information on years and months of widowhood duration was combined and rounded to the nearest decimal. The main independent variable of interest was widowhood – both status and duration – these were compared with currently married. Prior literature on widowhood and health has used varying classifications, both linear (Shin et al., 2018) and non-linear (Berntsen & Kravdal, 2012; Kung, 2020; Perkins et al., 2016). We used a categorical measure of widowhood duration (less than 10 years, 10–20 years, and 20+ years). A continuous measure of widowhood duration and an alternate categorical measure were also examined as robustness checks. It can be hypothesized that recently widowed women might have the lowest levels of cognitive functioning compared to married women and the longer-term widows due to the more recent disruption in social and economic support (Wilcox et al., 2003). For longer duration of widowhood, there may be some recovery as individuals adapt, or it could be the case that a cumulative disadvantage sets in during the long-term. An empirical investigation could help resolve this theoretical ambiguity.

General covariates. To estimate conditional differences in cognitive function by widowhood status, we employed control variables that are correlated with cognition, as well as variables that help account for selection into widowhood. We controlled for age, education, and log value of height (as a measure of childhood nutrition). Height and education are established correlates of later-life cognition (Case & Paxson, 2008; Glymour et al., 2008; Guven & Lee, 2015; Huang & Zhou, 2013; Maurer, 2010; Mosca & Wright, 2016; Weir et al., 2014), serving as proxies for early-life human capital. The measure of education is defined to be no schooling versus some since almost sixty percent of the women in the sample have had no formal education, and accordingly, the proportions of those with higher educational attainment were very small. We also controlled for socioeconomic status (henceforth SES) as measured by religion and caste. Geographic controls include residence in rural versus urban areas, and state of residence, since access to healthcare and cultural norms regarding women vary across these areas (Dyson & Moore, 1983), including widowhood (M. Chen & Drèze, 1992; Kadoya & Yin, 2015). Religion is grouped as Hindu, Muslim, or other religions, and caste is grouped as scheduled caste, scheduled tribe, other backward castes, or none of these since cultural norms regarding widowhood and remarriage among women have been historically more restrictive among Hindus and especially upper castes (M. Chen & Drèze, 1992; Jensen, 2005).

Mediators (modifiable). Economic, health, and social support measures were included as covariates, and further examined as potential mediators. These measures were chosen as mediators since they can potentially be modifiable via behavioral changes or economic/government support, and hence might be informative for designing interventions or public policies. We did not examine the general covariates described earlier as mediators since these can be reasonably assumed to be non-modifiable among the study sample of mid-aged and older

adults.[3]

Economic measures. Among economic variables, we used the logged value of annual per capita household consumption, whether the respondent lives in a *pucca* (using permanent materials) versus *kuccha* (using temporary materials) house, and whether the household has a below poverty line (BPL) or *Antyodaya* (for the poorest-of-poor) ration card. Using these three measures allows us to capture economic well-being as reported by the household financial respondent (consumption), as observed by the survey interviewer (type of house), and as per the government's official poverty classifications (ration card), mitigating measurement error in this domain. Consumption was used instead of household income since it has been found to be a more accurate measure of economic status in lower-income settings (Deaton, 1997).

Health measures. We used measures of mental health, objective physical health, and self-reported health. These are the Center for Epidemiological Studies Depression (henceforth CESD) score (Radloff, 1977), being underweight and poor self-reported health respectively. The CESD score ranges from 0 to 30, with higher scores indicating worse mental health. An individual was categorized as being underweight if their BMI was less than 18.5 kg/m^2. Self-reported health was measured on a scale from one to five indicating excellent (1), very good (2), good (3), fair (4), and poor (5) respectively. An individual was classified as having "poor health" if they reported their health to be fair or poor.

Social support *measures.* Variables capturing individual's social life and activities included whether co-residing with children, whether the individual shares personal matters with at least one person, whether they have any friends, whether they visit friends/relatives at least once a month and whether they attend religious events at least once a month. Using a combination of these variables allowed us to capture social life both inside and outside the household.

2.3. Statistical methods

Three kinds of statistical analyses were conducted. First were descriptive analyses, where we examined the overall unconditional mean difference in cognition by marital status, followed by non-parametric difference in cognition conditional on age, using kernel-weighted local polynomial smoothing. The second round of analyses were aimed at estimating the conditional disparity in cognition by widowhood status, using ordinary least squares (OLS) regression models. Model 1 controlled for age. Model 2 controlled for early-life human capital (as proxied by education and height). Model 3 added SES (caste and religion) and geographic (urban/rural, state of residence) controls. Model 4 controlled for all general covariates, and economic measures. Model 5 controlled for all general covariates, and health measures. Model 6 controlled for all general covariates, and social support measures. Model 7 controlled for all covariates. Similar OLS regressions were also estimated to examine the association between cognition and widowhood duration, where model 1 controlled for general covariates, model 2 controlled for all general covariates and economic measures, model 3 controlled for all general covariates and health measures, model 4 controlled for all general covariates and social support measures, model 5 controlled for all covariates. In the third set of analyses, economic, health and social support measures were examined as mediators, employing the inverse odds ratio weighting (IORW) methodology to estimate direct and indirect effects of widowhood on cognition (Tchetgen Tchetgen, 2013). IORW methodology was chosen since it allows multiple mediators (both continuous and categorical) and can be applied to any regression model (Nguyen et al., 2015). All

analysis use individual-level survey weights to obtain nationally representative estimates. Standard errors were clustered at the state level.

3. Results

3.1. Descriptive analyses

Sample characteristics. Fig. 2 presents the prevalence of widowhood by gender and age. While widowhood increases with age among both men and women, the increase is faster among women and reaches 50% by the age group of 65–69. Overall, only nine percent of the men are widowed, compared to 34 percent among women. Given these stark differences by gender, we focused on the subsample of women in this paper. Table 1 presents the summary statistics by widowed and married status among women, and the overall difference between the two groups. The cognition summary score is lower by 0.37 standard deviations (s.d.) on average for widows compared to married women – a difference which is large and statistically significant (p < 0.001). This is the unconditional widowhood disparity in cognition which we aim to further explain. The difference between average test scores for each component of the summary score across widowed and married women was also negative and statistically significant, hence we examined the difference in the summary cognition score in the main analysis. Statistics for score components are available in Appendix Table A1.

Widowed women are older than married women, a pattern which was also clear from Fig. 2. While the levels of formal schooling are low among older women in India, they are even lower for widowed women, among whom only 26 percent have had any formal education compared to 38 percent among married women. Overall, widowed women are shorter in height by approximately 2 cm, which could be due to their older age, or lower levels of nutrition in childhood. Widows are more likely to be in urban areas and southern regions of India compared to married women. The higher prevalence of widowhood in the south, a region perceived to have more favorable conditions for women, maybe due to fewer "missing women" (Anderson & Ray, 2012). The average duration of widowhood in the analysis sample is almost 15 years with a standard deviation of approximately 12 years, indicating a long widowhood duration in the analysis sample with wide variation.

Annual household per capita consumption is lower by approximately one thousand Indian Rupees (INR) among widows, which is approximately two percent lower than married women. Widowed women live in smaller-sized households (similar to (Drèze & Srinivasan, 1997)). Worse economic status among widowed women in the sample is further confirmed given that they are six percentage points less likely to be living in a *pucca* (permanent) house compared to married women. Greater need for economic support is also evident when we look at whether these women live in households that have a below poverty line (BPL) or extreme poverty (*Antyodaya*) ration card from the government – widowed women are five and two percentage points more likely to be part of BPL and *Antyodaya* ration card holding households respectively (p < 0.001).

Widowed women also have fewer social resources – such as social support or activities. While ninety-five percent of married women report sharing personal matters with at least one person, this proportion is lower for widows at eighty seven percent. Widowed women are also less likely to have friends, visit relatives/friends, or attend religious events compared to married women. However, both groups have similar rates of child co-residence, with seventy percent having at least one co-residing child. Widowed women also have worse mental and physical health. Compared to married women, widows are nine percentage points more likely to be underweight, ten percentage points more likely to self-report their overall health as poor, and have higher CESD scores by almost 1 (on a base of 9.6 and 8.7 mean scores).

Since widowhood sharply increases with age in our analysis while cognitive function, on average, declines with older age, it is important to consider if the overall widowhood difference in cognition of −0.37 s.d. is
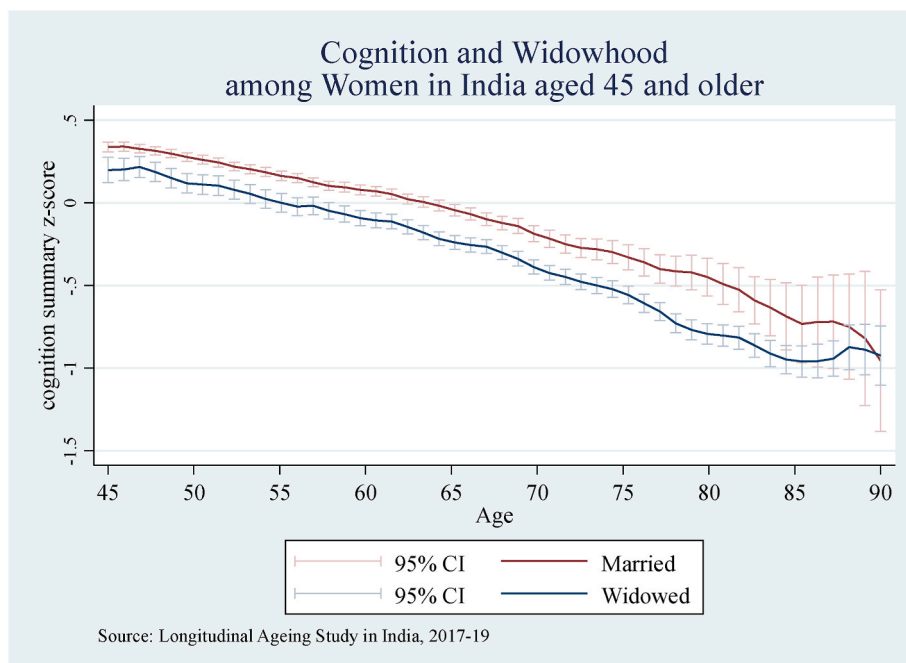
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[3] For example, education could be considered under economic measures, and height could be considered as a part of health measures. However, we did not examine these as mediators since these can be assumed to be non-modifiable for mid-aged and older adults.

Fig. 3. Non-parametric association between cognition and widowhood by age among older women in India.

simply due to an age effect. Fig. 3 presents the non-parametric relationship between cognition summary score and age by marital status. This figure indicates that the widowhood disparity is present even when conditioned on age, though the difference is reduced to about −0.15 s.d.

3.2. Regression estimates of widowhood disparity in cognition

Next, we present estimates of widowhood disparity in cognition conditional on a richer set of covariates in Table 2. Column 1 lists the baseline difference in cognition by widowhood conditional on age, which is used linearly as informed by the non-parametric pattern observed in Fig. 3. Column 2 adds measures of early-life human capital (education and height) as covariates, and the widowhood coefficient decreases to −0.08 s.d. However, the addition of SES measures and geographic controls in column 3 does not help explain the widowhood disparity considerably further. The addition of economic covariates in column 4 also does not help in further explaining the widowhood disparity. Controlling for health measures in column 5 does reduce the widowhood coefficient to −0.07 s.d. Inclusion of social support measures in column 6 does not change the widowhood coefficient. Finally, all covariates[4] (general, economic, health, and social support) are included in estimating column 7 coefficients, reducing the widowhood disparity to −0.06 s d.[5] However, the difference while greatly reduced remains statistically significant, suggesting that there are additional factors beyond these that could explain the difference.

Table 3 presents OLS estimates for the widowhood disadvantage in cognition compared to married women by the duration of widowhood. The coefficients on the categorical widowhood duration variable in column 1 suggest a non-linear relationship between cognition and widowhood duration, with lower cognition scores overall for women

who have been widowed for 10–20 years compared to married women and those who have been widowed for less than ten years but not different from those who have been widowed for more than 20 years. The inclusion of economic measures in column 2 reduces the coefficients on widowhood duration by 0.01 s.d. for all three groups, rendering the widowhood disparity for those widowed less than ten years statistically insignificant. Controlling for health measures in column 3 reduces widowhood disparity by 0.02 s.d. for those widowed for more than ten years and renders the widowhood disparity statistically insignificant for those widowed less than ten years, compared to column 1. Controlling for social support measures does not affect the widowhood disparity for the relatively recently widowed group and reduces the coefficient on widowhood duration for 10–20 years and 20+ years by 0.01 and 0.02 s. d. respectively, compared to column 1. The inclusion of all covariates (column 5) results in the widowhood disparity being insignificant for those widowed for less than ten years and reduces the coefficient on widowhood duration for 10–20 years and 20+ years by 0.04 and 0.03 s. d. respectively, compared to column 1. Fig. 4 shows the predicted values of cognition score for each of these groups based on the estimates from Table 3 and we see an initial decline in cognitive health for widows until 20 years but no major change for those who have been widowed for longer. As a robustness check, we also examined a continuous measure of widowhood duration, and another categorical measure with narrower durations. The linear association of cognition with widowhood duration was statistically significant but of a small magnitude (results in Appendix Table A2), while the alternate categorical measure did not yield any insights (Appendix Table A3) beyond those already apparent from the measure used in Table 3.

3.3. Mediation analyses

We next examine the extent to which mediating factors help explain the negative association between widowhood and cognition, estimating the indirect effect of mediating variables on cognition via widowhood, and accordingly the percent effect mediated using the IORW methodology. Table 4 presents these results for widowhood status. The magnitude of the total effect here is the same as the coefficient on widowhood in column 3 of Table 2. Estimates from column 1 suggest that the direct effect of widowhood status on cognition is significant,

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[4] We tested for multicollinearity among all covariates by checking the Variance Inflation Factors (VIF). Most VIF values were between 1 and 2, indicating very little correlation across these variables. Hence multicollinearity was not found to be a major concern.

[5] Almost identical empirical patterns were observed when using an alternate measure of cognition – summary score computed using principal component analysis. Results available on request.

Table 2

OLS estimates of widowhood disparity in cognition among women aged 45 and older in India.

VARIABLES	baseline	add early-life human capital	add SES and geographic controls	economic status	health measures	social support measures	all covariates
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable: cognition summary z-score							
Reference group: married							
Widowed	−0.15***	−0.08***	−0.09***	−0.08***	−0.07***	−0.08***	−0.06**
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Age	−0.02***	−0.01***	−0.02***	−0.02***	−0.01***	−0.01***	−0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Education reference group: no school							
Any schooling		1.07***	0.92***	0.87***	0.90***	0.91***	0.85***
		(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)
Log(height)		2.31***	1.80***	1.64***	1.72***	1.71***	1.52***
		(0.17)	(0.29)	(0.28)	(0.29)	(0.28)	(0.27)
Religion reference group: Hindu							
Muslim			−0.18***	−0.17***	−0.18***	−0.17***	−0.16***
			(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Other religions			0.06	0.06	0.06	0.05	0.04
			(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Caste reference group: Non disadvantaged castes							
Scheduled Caste			−0.18***	−0.14***	−0.16***	−0.17***	−0.13***
			(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Scheduled Tribe			−0.40***	−0.34***	−0.38***	−0.39***	−0.32***
			(0.09)	(0.08)	(0.08)	(0.09)	(0.08)
Other Backward Castes			−0.11***	−0.09***	−0.11***	−0.11***	−0.09***
			(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Reference group: urban							
Rural			−0.25***	−0.20***	−0.21***	−0.25***	−0.18***
			(0.02)	(0.02)	(0.02)	(0.01)	(0.02)
Log per capita household consumption				0.09***			0.07***
				(0.02)			(0.02)
Pucca house				0.10***			0.08***
				(0.02)			(0.02)
BPL/*Antyodaya* ration card				−0.04*			−0.04
				(0.02)			(0.02)
CESD					−0.01***		−0.01***
					(0.00)		(0.00)
Underweight					−0.20***		−0.17***
					(0.02)		(0.01)
Self-reported poor health					−0.06***		−0.05***
					(0.02)		(0.02)
Co-residing with children						0.03	0.04
						(0.03)	(0.03)
Share personal matters with at least one person						0.11***	0.10***
						(0.02)	(0.02)
Any friends						0.20***	0.20***
						(0.03)	(0.04)
Visit relatives/friends at least once a month						0.11***	0.10***
						(0.02)	(0.02)
Attend religious functions/events at least once a month						0.06**	0.05**
						(0.03)	(0.02)
Observations	29,242	29,242	29,242	29,242	29,242	29,242	29,242
Adjusted R-squared	0.09	0.38	0.43	0.44	0.44	0.45	0.46

Data source: Longitudinal Ageing Study in India, 2017–19. *Notes.* Sample consists of married or widowed women aged 45–90. Column (2) adds education and log (height) as covariates. Column (3) further controls for religion, caste, urban/rural residence, and state fixed effects. Column (4) controls for all covariates until column (3), and adds log(per capita household consumption), whether the individual resides in a *pucca* (permanent) house, and whether the household has a below poverty line (BPL) or *Antyodaya* ration card. Column (5) controls for all covariates until column (3), and adds CESD score, underweight, and self-reported poor health. Column (6) controls for all covariates until column (3), and adds co-residence with children, sharing personal matters with at least one person, whether the individual has any friends, visiting relatives/friends at least once a month, and attending religious functions/events at least once a month. Column (7) controls for all covariates until column (3), and covariates from columns (4), (5), and (6). Individual-level analysis weights were used to obtain nationally representative estimates. Standard errors clustered at the state level in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

while economic measures do not have a significant indirect effect on cognition via widowhood. Health measures as mediators (column 2) are found to have a significant indirect effect on cognition, with almost twenty nine percent of the relationship between widowhood and cognition mediated via mental and physical health. Social support measures are not found to have significant indirect effects on cognition via widowhood (column 3). All mediators are examined together in column 4, and results suggest that up-to forty five percent of the effect of widowhood on cognition may be mediated via a combination of economic, health, and social support measures.

Table 5 presents the results of IORW mediation analysis for widowhood duration. The magnitude of total effects here is the same as coefficients on widowhood duration categories in column 1 of Table 3. When comparing women widowed for less than ten years with married women, none of the mediators are found to have a significant indirect effect. Among those widowed for 10–20 years, the indirect effect of health on cognition is significant, but only weakly so. The overall indirect effect of all mediators is estimated to be almost thirty percent for this group of widows, but the estimate is again weakly significant. Lastly, among those widowed for 20 years or more, the indirect

Table 3
Widowhood disparity in cognition by widowhood duration.

	baseline	economic status	health measures	social support measures	all covariates
	(1)	(2)	(3)	(4)	(5)
	Dependent variable: cognition summary z-score				
Reference group: married					
Widowhood duration: 0–10 years	−0.05*	−0.04	−0.04	−0.05*	−0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Widowhood duration: 10–20 years	−0.13***	−0.12***	−0.11***	−0.12***	−0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Widowhood duration: 20+ years	−0.11***	−0.10***	−0.09**	−0.11***	−0.08**
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Log per capita household consumption		0.09***			0.07***
		(0.02)			(0.02)
Pucca house		0.10***			0.08***
		(0.02)			(0.02)
BPL/*Antyodaya* ration card		−0.04			−0.04
		(0.02)			(0.02)
CESD			−0.01***		−0.01***
			(0.00)		(0.00)
Underweight			−0.20***		−0.17***
			(0.02)		(0.01)
Self-reported poor health			−0.06***		−0.05***
			(0.02)		(0.02)
Co-residing with children				0.03	0.04
				(0.03)	(0.03)
Share personal matters with at least one person				0.11***	0.10***
				(0.02)	(0.02)
Any friends				0.20***	0.20***
				(0.03)	(0.04)
Visit relatives/friends at least once a month				0.11***	0.10***
				(0.02)	(0.02)
Attend religious functions/events at least once a month				0.06**	0.05**
				(0.03)	(0.02)
Observations	29,242	29,242	29,242	29,242	29,242
Adjusted R-squared	0.43	0.44	0.44	0.45	0.46

Data source: Longitudinal Ageing Study in India, 2017–19. *Notes.* Sample consists of married or widowed women aged 45–90. Column (2) controls for log(per capita household consumption), whether the individual resides in a *pucca* (permanent) house, and whether the household has a below poverty line (BPL) or *Antyodaya* ration card. Column (3) controls for CESD score, underweight, and self-reported poor health. Column (4) controls for co-residence with children, sharing personal matters with at least one person, whether the individual has any friends, visiting relatives/friends at least once a month, and attending religious functions/events at least once a month. Column (5) controls for all covariates in prior columns. Following covariates are included in all estimations, with coefficients not shown: age, education, log (height), religion, caste, urban/rural residence, and state fixed effects. Individual-level analysis weights were used to obtain nationally representative estimates. Standard errors clustered at the state level in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
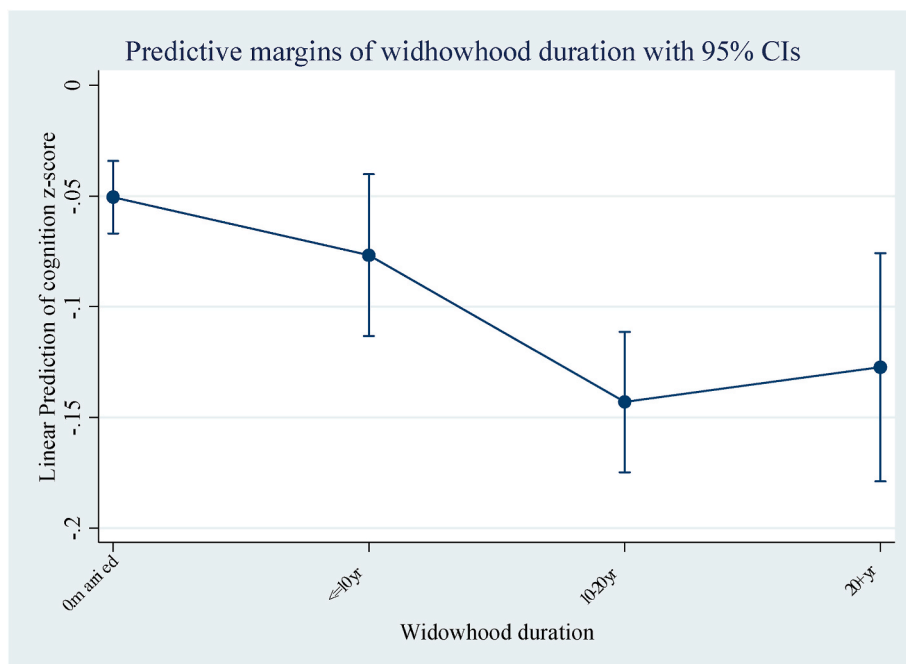

Fig. 4. Predicted values of cognition by duration of widowhood among older women in India.

Table 4
Direct and indirect effects of widowhood on cognition: mediation analysis using Inverse Odds Ratio Weighting (IORW).

	(1) economic status	(2) health measures	(3) social support measures	(4) all mediators
Indirect effect	−0.02	−0.03**	−0.02	−0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Direct effect	−0.07***	−0.06***	−0.07***	−0.05**
	(0.02)	(0.02)	(0.02)	(0.02)
Total effect	−0.09***	−0.09***	−0.09***	−0.09***
	(0.02)	(0.02)	(0.02)	(0.02)
Percent effect mediated	22.39	28.86**	21.13	44.89***
	(16.38)	(14.66)	(15.35)	(17.31)
Observations	29,242	29,242	29,242	29,242

Notes: Coefficients for all effects control for age, education, log(height), religion, caste, urban/rural residence, and geographic state. Indirect effect = Total effect – Direct effect. Percent effect mediated calculated as (Indirect effect/Total effect)X100. For further details on IORW, please refer to Tchetgen Tchetgen (2013). Economic status mediators used in column (1): log(per capita household consumption), whether the individual resides in a *pucca* (permanent) house, and whether the household has a below poverty line (BPL) or *Antyodaya* ration card. Health mediators in column (2): CESD score, underweight, and self-reported poor health. Social support mediators used in column (3): co-residence with children, sharing personal matters with at least one person, whether the individual has any friends, visiting relatives/friends at least once a month, and attending religious functions/events at least once a month. All mediating variable used in column (4). Bootstrapped standard errors clustered at the state level in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

mediating effect of health is significant but at 10% significance level. Hence, health variables mediate the relationship between widowhood and cognition to a considerable extent, but not those pertaining to economic conditions or social support.

4. Discussion

The findings from the analysis address the hypotheses we aimed to test as follows. The first hypothesis, that older widowed women in India have lower cognitive function compared to married women is confirmed as the magnitude of the unconditional widowhood disparity, −0.37 s d, which reduced to −0.06 s.d. after controlling for a rich set of SES covariates but remained statistically significant. This finding is consistent with the broader literature in this line suggesting that married people enjoy better health and well-being than unmarried people including the widowed (Liu, Zhang, et al., 2020). This is one of the first studies to examine "marital advantage" in cognitive health in the context of India, a low-income country that is understudied in previous literature in this line, and has the largest population of widows in the world with little social security to rely on (Harma, 2016).

Our second hypothesis is also confirmed, as the results suggest that widowhood may have long-lasting impacts on cognition that could extend up to 20 years after the transition to widowhood. Our findings are generally consistent with the cumulative disadvantage/advantage argument (Dannefer, 2003). Yet, our results also suggest that the negative relationship of widowhood to cognitive health may eventually stabilize, although the process may play out over up to twenty years. Another plausible explanation for the stabilization of the magnitude of these impacts is that selective mortality would be of largest concern for those who have been widowed for two decades or longer, compared to those with relatively shorter widowhood durations.

We posit that there are two main sources of selection bias to be considered that could lead to an attenuation in our estimates. First, since widowed individuals generally have a higher mortality rate than their married counterparts (Moon et al., 2011), mortality selection could result in our estimates being downward-biased. The strength of this bias would likely increase with the duration of widowhood as the long-term

Table 5
Direct and indirect effects of widowhood on cognition by widowhood duration: mediation analysis using Inverse Odds Ratio Weighting (IORW).

	(1) economic status	(2) health measures	(3) social support measures	(4) all mediators
Widowhood duration: 0–10 years				
Indirect effect	−0.00	0.00	0.00	−0.01
	(0.02)	(0.01)	(0.01)	(0.02)
Direct effect	−0.05**	−0.05***	−0.05***	−0.04**
	(0.02)	(0.02)	(0.02)	(0.02)
Total effect	−0.05***	−0.05***	−0.05***	−0.05***
	(0.02)	(0.02)	(0.02)	(0.02)
Percent effect mediated	1.70	1.90	1.09	18.50
	(38.84)	(36.96)	(41.73)	(40.33)
Widowhood duration: 10–20 years				
Indirect effect	−0.02	−0.03*	−0.02	−0.04*
	(0.02)	(0.02)	(0.02)	(0.02)
Direct effect	−0.11***	−0.10***	−0.11***	−0.09***
	(0.03)	(0.03)	(0.03)	(0.03)
Total effect	−0.13***	−0.13***	−0.13***	−0.13***
	(0.03)	(0.03)	(0.03)	(0.03)
Percent effect mediated	13.48	20.00	12.60	29.31*
	(17.34)	(16.64)	(19.87)	(19.33)
Widowhood duration: 20+ years				
Indirect effect	−0.05	−0.06*	−0.04	−0.05
	(0.04)	(0.03)	(0.03)	(0.04)
Direct effect	−0.06*	−0.06*	−0.08**	−0.06*
	(0.04)	(0.03)	(0.03)	(0.03)
Total effect	−0.11***	−0.11***	−0.11***	−0.11***
	(0.03)	(0.03)	(0.03)	(0.03)
Percent effect mediated	44.60	48.43	33.38	46.76
	(34.06)	(31.76)	(31.58)	(33.36)

Notes: Coefficients for all effects control for age, education, log(height), religion, caste, urban/rural residence, and geographic state. Indirect effect = Total effect – Direct effect. Percent effect mediated calculated as (Indirect effect/Total effect)X100. For further details on IORW, please refer to Tchetgen Tchetgen (2013). Economic status mediators used in column (1): log(per capita household consumption), whether the individual resides in a *pucca* (permanent) house, and whether the household has a below poverty line (BPL) or *Antyodaya* ration card. Health mediators used in column (2): CESD score, underweight, and self-reported poor health. Social support mediators used in column (3): co-residence with children, sharing personal matters with at least one person, whether the individual has any friends, visiting relatives/friends at least once a month, and attending religious functions/events at least once a month. All mediating variable used in column (4). Bootstrapped standard errors clustered at the state level in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

widows who survived widowhood and the ensuing disadvantages for ten years or longer may be a highly selective (e.g., more resilient) group relative to the group of widows who are not in the sample due to mortality as they succumbed to the various widowhood-related disadvantages. A second potential source of attenuation bias could be the phenomenon of "missing women" in India. Since this sub-population of older widows is more susceptible to be "missing" (Anderson & Ray, 2019), those who survive this population-level risk of being purged – the group who are documented in households in our sample – are likely to have either overcome or been less susceptible to the risks of abandonment and mortality. Hence, the widows in our analysis sample are likely to be a more advantaged group with plausibly better outcomes, including cognitive health, compared to widows who are "missing." This again would lead to a downward bias in our estimates as we do not observe in our sample the group of older "missing" widows who possibly had worse circumstances and outcomes.

The third hypothesis tested for the extent to which economic, social, and health factors might further explain the widowhood disparity in cognition. Our results suggest that worse health emerged as the most important mediator, with almost thirty percent of the total effect of widowhood status on cognition being mediated via physical and mental health. Factors pertaining to economic well-being and social support

were not found to have significant indirect effects on cognition via widowhood status. Health mediators mattered more in explaining the widowhood disparity among widows with widowhood duration more than ten years compared to those widowed for less than ten years, which could also be explained by cumulative disadvantage (Dannefer, 2003). It is possible that the social support variables we used may not measure other important social dimensions related to the experience of widowhood, e.g., the quality of social and emotional support.

This paper is not without limitations. Our results, while explaining the associations using a rich set of mediators and a comprehensive measure of cognition, merit limited and cautious causal inference due to the cross-sectional nature of the data. Some of the potential concerns would be estimates being biased due to unobserved individual heterogeneity, and simultaneity. Longitudinal analysis of transitions into widowhood, increasing widowhood duration, and the trajectory of cognitive health along with the mechanisms would help shed further light on the dynamics of our findings.

5. Conclusion

Widowhood is widely documented to be a highly stressful life event, leading to economic and health disruptions and worse outcomes for widowed individuals. Such stressors have been found to be associated with worse cognitive health and a higher risk of dementia (Sommerlad et al., 2018), but more evidence is needed from low-income countries and on the mediating factors behind these associations. Older female widows in India face a unique set of challenges as the social norms for their conduct after the death of a spouse can be rather restrictive. Hence, in this paper, we examined the association between widowhood and cognitive function among older women in India.

Using nationally representative data from the first wave of LASI on adults aged 45 and above in India, we found that among women, widows have significantly lower cognition than married women, and this disparity while initially increasing with widowhood duration, stabilized after twenty years of widowhood. We further found that physical and mental health factors help explain the widowhood disparity in cognition to a larger extent but not factors capturing economic well-being and social life. These mediating factors also seem most essential among those with widowhood duration longer than ten years.

The sub-population of older widows in India is a particularly disadvantaged and vulnerable group. Hence, the findings of this paper recommend that health professionals and the government recognize and consider older widows to be at a greater risk of cognitive disadvantage and related adverse health outcomes, and accordingly design and implement public health interventions and social policy.

Contributor statement

Conceived and designed the research paper: KL, UJ, HL, MF, and MK; analyzed the data: UJ; Wrote the manuscript: UJ, HL, KL, and MF; Refined the manuscript: HL, UJ, KL, MF, MK, and JL. All authors read, reviewed, and approved the manuscript.

Ethics approval statement

The research did not involve human subjects as it was conducted using publicly available, de-identified secondary data. Therefore, the researchers will have no access to personal identifiers or personal health information that can be linked to individuals while analyzing the data.

Declaration of competing interest

None.

Data availability

The study uses secondary data which is available on request through https://www.iips.ac.in.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2022.101242.

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