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Structural Ageism Impact on Greater Violence Against Older Persons: A Global Analysis of 56 Countries

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Structural Ageism Impact on Greater Violence Against Older Persons:

A Global Analysis of 56 Countries

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Abstract

Objective: To determine the association between country-level structural ageism and prevalence of violence against older persons.

Design: Country-level ecological study.

Setting: Structural ageism data were drawn from the nationally-representative World Values Survey 2010-2014 (WVS), global databases from the World Health Organization (WHO), United Nations (UN), and World Bank. Violence data were based on the Global Burden of Diseases Study 2017 (GBD).

Participants: Analysis of 56 countries that represented 63.1% of the world's aging population aged 60 and over across all six of WHO regions.

Exposure: Structural ageism, following established structural stigma measures, was a composite combing two components: (1) national policies related to older persons' economic, social, civil, and political rights, based on the four core components of human rights protection in Madrid International Plan of Action on Aging; and (2) prejudicial social norms against older persons, measured by negative attitudes toward older persons in 56 national polls in WVS aggregated to country-level. These two components were z scored and combined such that higher score indicated greater structural ageism.

Main Outcomes and Measures: Prevalence rates of violence in 100,000 persons aged 70 and over in each country was based on extensive epidemiological surveillance data, survey, clinical data, and insurance claims in GBD and compiled by the Institute of Health Metrics and Evaluation, University of Washington.

Results: There was wide variation in levels of structural ageism across countries. As predicted, structural ageism was significantly associated with the prevalence rates of violence in

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multivariate models (β =205.7, SE=96.3, *P*=.03), after adjusting for relevant covariates.

Sensitivity analyses supported the robustness of our findings. That is, structural ageism did not

predict other types of violence and other types of prejudice did not predict violence against older

persons.

Conclusions: This study provides the first evidence of the association between higher structural

ageism and greater violence against older persons across countries.

Strengths and Limitations of this study

- The current analysis, which is based on 56 countries that represented 63.1% of the world's aging population aged 60 and over across all six of WHO regions, examines a previously unexplored link between structural ageism and violence against older persons.

- Structural ageism, measured by a composite score combining discriminatory social policies and prejudicial social norms against older persons, was significantly associated with higher prevalence rates of violence against older persons after controlling for sociodemographic, economic, and health covariates.

- By filling gaps in previous analyses of the ageism-health research, the findings underscore the scope of ageism as a social determinant of health.

- The ecological design with country-level information may not provide inference to individual-level data.

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Introduction

Violence directed against older persons is a pervasive public health problem. Globally, prevalence of violence against older persons has increased significantly over the last two decades.[1] One in six older persons experiences elder abuse in the past year.[2] Older persons' safety may be particularly compromised during the current COVID-19 pandemic as they experience increased exposures to wide-spread age-based discrimination, social isolation with perpetrators, and reduced options for support.[3,4] The associated social, psychological, and financial stressors further present significant barriers for reporting and help-seeking.[5] To this end, the United Nations has called for improved protection for older persons' safety and well-being during this health crisis.[6]

Addressing violence against older persons require population-level solutions. The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have strongly recommended integration of a socio-ecological framework in violence prevention research and practice.[7] Based on this multi-level model, risk factors for violence against older persons operate across individual, relationship, community and societal levels of social ecology, that jointly place individuals at a higher risk of violence victimization and perpetration. However, the majority of research on violence against older persons pertain to individual factors.[8] Compounding this lack of evidence beyond individuals is the disproportionate focus on the deficits of victims that erroneously suggests victims are to be blamed.[9]

Societal-level risk factors in violence against older persons deserve more attention given that interventions are most effective when context-changing strategies are in place.[10] This knowledge void may be owing to a few conceptual, measurement, and methodological challenges. While contexts shape interactions, existing theories have largely overlooked the

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ways in which macro-level factors, such as policies and cultural norms specific to aging, may be linked to downstream individual behaviors. To avoid same-person bias in measuring older persons' social environment,[11] a novel approach that provides a non-self-report indicator is also needed. Additionally, cross-national comparisons are lacking in this line of research.[8] With data typically collected in a single country, participants' responses may be restricted by the particular cultural climate in that country, hence limiting the understanding of the role of societal determinants on violence victimization and perpetration across cultures.[12]

As the most widespread form of bias and prejudice,[13,14] ageism harms older persons' health simultaneously at both structural and individual levels. At the structural level, ageism is manifested in the forms of explicit and implicit policies, practices, or social norms that impose bias and discrimination against older persons. At the individual level, ageism is manifested by negative age stereotypes and negative self-perceptions of aging. As premised by the Stereotype Embodiment Theory (SET),[15] both levels are closely intertwined because individual-level ageism is assimilated by older persons from surrounding cultures that propagate structural ageism. A recent systematic review based on 7 million older participants across 25 years found evidence the injurious health effects of structural ageism existed in 45 countries, but none of the studies included examined violence against older persons as the health outcome.[16]

There are strong theoretical and empirical evidence from parallel tracks of violence research against children and women to suggest the potential link between structural ageism and violence against older persons.[17] However, until now, this hypothesis has remained an assumed link and has not been tested.[18] In this present study, we predicted that structural ageism would be associated with greater prevalence of violence against older persons, after adjusting for socioeconomic and health risk factors.

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Methods

Data Sources

Data for our predictor, structural ageism, were drawn from the latest available wave of

World Values Survey (WVS) in 2010-2014 and global health databases including the World

Health Organization (WHO) and United Nations (UN). The WVS consists of nationally

representative polls of individuals' attitudes and behaviors since 1981.[19] Outcome data on the

prevalence estimates of violence were drawn from the Global Burden of Disease Study (GBD) in

2017 compiled by the Institute of Health and Metrics Evaluation (IHME) at the University of

Washington.[20] Data sources for covariates included WHO and the World Bank. Countries that

had data for structural ageism measures and prevalence estimates for violence formed our final

analyses, which was consisted of 56 countries representing 82,249 respondents in WVS.[19]

Together, these countries accounted for 63.1% of the global older population aged 60 years and

older, representing all six WHO regions.

Exposures: Structural Ageism

To operationalize structural ageism, we followed a methodologically-validated approach

informed by extensive scholarship on structural stigma: discriminatory social policies and

prejudicial social norms.[11,21,22] Discriminatory social policies referred to macro-level policies

and practices that discriminate against or restrict the resources and opportunities for older

persons. In order to match with prejudicial social norms that were measured between 2010 to

2014 in the WVS, the presence of four policies between 2010 to 2014 selected for the present

index reflected four core components of human rights protection in the Madrid International Plan

of Action on Aging[23], including economic, social, civil, and political rights.[24] As the most

comprehensive international policy framework to address population aging,[25] the Madrid Plan

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strives to eliminate all forms of violence and discrimination against older persons.[24] In our

index, the protection of economic rights was based on whether or not each country had enacted

pension reform laws including raising retirement benefits of workers as initially reported by

country, and then subsequently validated and reported by UN experts in UN's World Population

Policies database.[26] The protection of social rights- or recognizing older persons as a social

group deserving of their own rights, was assessed by coding the presence of national policies that

included healthy aging as a priority policy. Each country self-reported whether or not they have

developed laws to protect the well-being of their aging populations. Data were collected and

compiled by United Nations Population Fund (UNFPA).[27] The protection of civil rights was

based on the existence of employment non-discrimination policies for older workers, drawn from

expert evaluation in the publicly available Employment Protection Legislation Database, UN's

International Labor Organizations.[28] The protection of political rights was based on the

existence of constitutional-level protection against age discrimination, reported by each country

and compiled by UNFPA.[27]

The absence or presence of each of these 4 policies were summed into a continuous

variable, ranging from 0 to 4. Higher score indicated that a country had greater structural

ageism, as indicated by fewer policies protecting older persons. Overall, 17.9% had one

discriminatory policy, 42.9% had two discriminatory policies, 16.1% had all four indicators of

discriminatory policies. Only one had zero (Spain) (see table 1 in the Supplement).

The second domain in our index pertains to societal-level prejudicial attitudes toward

older persons that reflects overarching public opinions.[22,29] Participants in WVS were asked

their level of agreement on "older persons are a burden on society." Score ranged from 1 to 4,

with high levels indicated higher level of burden. The mean value was aggregated at the

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country-level. Higher values indicate more prejudicial social norms against older persons. Mean (SD) was 1.8 (0.2) that ranged from 1.2 to 2.4. Overall, 45.0% of all countries reported above-average level of endorsement in this statement.

Following analytical procedures in creating structural stigma indices,[30,31] we standardized the scores for each of the two domains separately, and then summed up both z-transformed score to create the structural ageism index. Given the values ranged from negative to positive in standardized scores, to ease interpretation, we added the positive value of the lowest negative value across all scores, so that the final scores would be equal or larger than 0. A separate exploratory factor analysis showed that both domains loaded on the same factor (eigenvalues>1.0; factor loading= .74), suggesting one underlying latent factor that indicated structural ageism in the index.

Structural ageism was examined as a continuous variable in the bivariate and multivariable models. As a secondary analysis to quantify risk levels of structural ageism in relation to prevalence of violence, we operationalized structural ageism as a categorical variable based on tertiles of final scores (i.e., low-, medium-, and high-level of structural ageism).

Outcome: Prevalence Estimates of Violence against Older Persons

We obtained prevalence estimates of violence from the Global Burden of Disease Study (GBD), one of the most comprehensive cross-national epidemiological studies on injuries, morbidities, and mortality based on extensive survey, epidemiological surveillance, and clinical data sources.[20] Recent reiteration of GBD was conducted by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington using Bayesian meta-regression model to estimate rates of prevalence for each health and injury domain. In 2017, GBD was based on 68,781 data sources used for the analysis of nonfatal causes of disease and injury for a total of

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354 causes.[20] Estimates were presented for those 70 and over which we used within each of the 56 countries. GBD defined interpersonal violence according to the International Classification of Diseases (ICD)-10 (X85-Y08.9, Y87.1)[32] that covered three categories: (1) physical assault by any means, including firearm, bodily force, sharp or blunt objects, (2) sexual assault by bodily force, and (3) mistreatment, neglect, and abandonment, including physical abuse, sexual abuse, torture and cruelty. The prevalence of violence victimization used in this study was prevalence rate of both fatal and non-fatal violence victimization per 100,000 persons in the age group of 70 years and over that covered all three categories of interpersonal violence.

Country-level Covariates

We considered a wide range of socio-demographic and health covariates a priori owing to the known relationships with violence.[17,33-37] These potential covariates, assessed in 2010 to match with the timing of the predictor, included (1) population ratio, measured by the proportion of the population 70 years and older relative to that of the younger-age population (20-69), (2) gross national income (GNI) per capita (in 1,000 international dollar increments), (3) average years of schooling, (4) unemployment rate, and (5) alcohol consumption per capita. To maintain study power and create the most parsimonious model, we performed a backward selection stepwise regression model based the Akaike Information Criterion (AIC).[38] Stepwise regression models were commonly applied in previous country-level ecological studies of violence with relatively smaller sample sizes. [39,40] Three covariates that characterized country-level socio-economic and health portfolios were retained in the final multivariable model: population ratio, GNI per capita, and alcohol consumption per capita.

Statistical Analysis

Pearson correlation coefficients were used to examine the association between structural ageism, violence prevalence estimates, and covariates. Bivariate and multivariable linear regression models were used to estimate the relationship between structural ageism and prevalence rates of violence. Goodness of fit of the models to the data was evaluated using AIC. We used residual plots and multi-collinearity diagnostics to examine issues of heteroscedasticity and multi-collinearity. To evaluate potential outliers in the model, we examined whether any observations was more than one Cook's distance.[41]

To examine the robustness of the findings, we conducted several additional sensitivity analyses. First, to examine the discriminant validity of the structural ageism index, analyses of the study were performed replacing the prevalence rates of violence in older age groups with the estimates of violence in children in the forms of violent disciplines and peer violence. We hypothesize that structural ageism would not be related to estimates of violence in children. Data were drawn from nationally representative surveys in the UNICEF global databases.[42] Violent discipline by caregivers included psychological aggression, physical, and corporal punishment, as measured by the Parent-Child Conflict Tactics Scale.[43] Peer-violence was measured by the proportion of students aged 13-15 years who reported being bullied on one or more days in the past 30 days. The number of countries that had available estimates of violent discipline and peer violence during years of 2014-2017 that matched with participating countries in WVS were 19, and 21, respectively.

The second sensitivity analysis examined the predictive validity of the structural ageism index by assessing the relationship between anti-immigrant, racial prejudice and prevalence estimates interpersonal violence in older age. We hypothesize that anti-immigrant and racial prejudice attitudes would not be related to interpersonal violence in older age. Anti-immigrant

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and racial prejudice attitudes were drawn from the WVS. Participants were asked to state which

groups they would not like to have as neighbors: "People of another race," or

"Immigrants/foreign workers." This measure has been used to assess negative attitudes toward

minority group members.[44,45]

The third sensitivity analysis examined whether the effects of structural ageism on

violence prevalence estimates were only specific to older age groups, but not younger age

groups. Based on GBD 2017, we obtained prevalence rates of violence in age 15 to 49 years old.

All analyses were conducted in SAS (version 9.4, SAS Institute Inc., Cary, NC). This

study was exempted by Yale University's Institutional Review Board.

Patient and public involvement

Neither patients nor the public were involved in this research.

Results

As predicted, structural ageism was significantly associated with higher prevalence of

violence against older persons. This was found in both bivariate (β =261.0, SE=106.0, P=.02).

and multivariable models (β =205.7, SE=96.3, P=.03). After controlling for covariates, a one

standard deviation increase in the structural ageism index was associated with a 205.7 per

100,000 persons increase in the prevalence of violence against older persons aged 70 years and

older. Also as predicted, in a secondary analysis that included the categorization of the low-,

medium-, and high- structural ageism predictor, there was a linear pattern between increasing

levels of ageism and higher prevalence rates of violence, after adjusting for covariates (test for

linear trend: P = .02) (figure 1).

With respect to model diagnostics, collinearity diagnostics indicated no evidence of

multicollinearity. Residual plots have confirmed the model assumptions (normality and

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homoscedasticity of residuals) had been met. All but two cases (China and Qatar) had a larger than Cook's Distance cut-off of one for outliers. When we removed China and Qatar respectively from the multivariable model estimates, the positive association between structural ageism and prevalence remained significant.

Our results showed wide variation in levels of structural ageism across countries, with higher value indicating greater structural ageism (total values ranged from 0 to 7.3) (table 1). Nigeria, Lebanon, and Belarus reported highest structural ageism. Uzbekistan, Cyprus, and Spain had the lowest structural ageism. China, Russia, and Zimbabwe had the highest prevalence rates of violence against older persons; whereas Singapore, Germany, and Egypt had the lowest prevalence rates of violence against older persons.

Results from three sensitivity analyses suggested the robustness of the results. First, in support of the discriminant validity of structural ageism index, ageism was not correlated with violent discipline (R=0.31, P=.21) or bullying (R=-0.13, p=.59). Second, in support of the predictive validity of structural ageism index, anti-immigrant and racial prejudice were not correlated with violence estimates against older persons (R= -0.18, P=.20; R= -0.17, P=.20; respectively). Third, the relationship between structural ageism and violence was non-significant in the younger age group of 15 to 49 years old, suggesting the validity of our findings.

Discussion

This study investigated a previously unexplored relationship between structural ageism and violence against older persons. As predicted, we found that structural ageism is significantly associated with prevalence rates of violence against persons aged 70 and over, after controlling for known risk factors. Findings in this study may help policymakers, national and international

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health authorities, and health care professionals address the growing global health burden of violence in older persons.

Public health research on improving support structures and societal-based solutions is needed to effectively prevent violence against older persons at a large scale, especially in times of unrest and relative instability. A recent CDC report estimated that the rate of nonfatal assaults against persons 60 years and older has risen by 53% between 2008 and 2016.[46] Additionally, recent reports have indicated increasing rates of interpersonal violence in family settings during the ongoing COVID-19 pandemic.[47] As social isolation and psychological stressors continue to intensify during the ongoing pandemic as the consequences of self-quarantine, expanding structural-level program response to improve the safety of older persons would be essential.

The mechanism through which structural ageism elevated risks for violence victimization in older persons warrants further investigation. As premised by SET,[15] ageism operated at the structural level is assimilated and internalized at the individual level. Thus, it could be that the legitimization of unfair treatment based on age, compounded by disparaging views of older persons, would allow for greater tolerance for violence and likely make violence and abuse more permissive for perpetrators.[48] Additionally, one might postulate that in social contexts that denigrate a group, individuals tend to be more accepting in violence toward that group. For instance, research in family violence has found that cultures with greater sexism exhibited higher tolerance of intimate partner violence.[49,50] These structural mechanisms remain to be tested in future research.

A strength of our investigation was it examined country-level structural ageism combining social laws and norms. The wide variation in country-level attitudes toward older persons was in line with previous cross-cultural analyses.[51,52] In the domain of policies, we also

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found variation in the level of each country's protection toward older persons. This may be a reflection of the gap in existing legal provisions and international conventions specifically supporting the rights of older persons.[53]

Congruent with intersectional theories,[54] our findings showed that countries reported higher structural ageism coincided with those that also reported greater inequality in other realms of stigma. For instance, Nigeria ranked among the highest in structural ageism in this study as well as highest in structural stigma against sexual minorities in a recent cross-cultural study of 197 countries.[55] The opposite estimate was found in Spain where it ranked among the lowest in both structural stigma measures. As structural systems of oppression are often mutually manifested to reinforce health inequalities, analyses that only focus on gender, race, ethnicity alone are insufficient to understand population-level health disparities.[56] Future efforts are needed to examine the joint effects of multiple intersecting stigmas, including age stigma, in predicting health.

Integrating structural ageism as a societal-level risk factor in existing elder abuse research may also help inject a multi-systemic, socio-cultural lens in developing much-needed interventions.[57] Theories of elder abuse have been predominantly interpersonal in nature, where victims of abuse were typically described as uniformly dependent and powerless.[58-60] The emphasis on older persons' vulnerabilities not only erroneously intensifies victim-blaming, but also shifts our attention away from the broader status inequality that each individual is embedded in. Considering the ways in which structural ageism seep through social interactions and its downstream consequences in shaping the inherent power imbalance between victims, perpetrators, and their environments can offer promising opportunities for primary prevention strategies.[48]

Our findings hold important implications for violence prevention programming. First, ageism that operates at both individual and structural level deserves more consideration in estimating the occurrence of violence and abuse in older persons. Second, social and legal policies are inherently public health policies.[61] Social policies that protect the rights of older persons may reap significant public health benefits for population-level violence preventions. Third, as existing approaches for violence preventions are tailored toward individual ecology, positioning structural ageism as a societal risk factor of violence against older persons may help catalyze a paradigm shift in refining current primary preventions against violence and abuse. Such structural approach may focus on reducing ageism through improving political-legal, economic, as well as intergenerational support for older persons.[3]

Conclusions

Our results highlight that structural ageism is a social determinant of aging health disparities that deserved attention. Public health and population-based violence prevention policies may benefit from a targeted approach that tackles the harmful effects of structural ageism.

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Contributors

EC was involved in study conceptualization and design, data collection, analyses, interpretation

of results and manuscript writing. JM and DZ contributed to study design, analyses and

manuscript writing. BL contributed to study conceptualization and design, supervised analyses,

and contributed to interpretation of results and manuscript writing.

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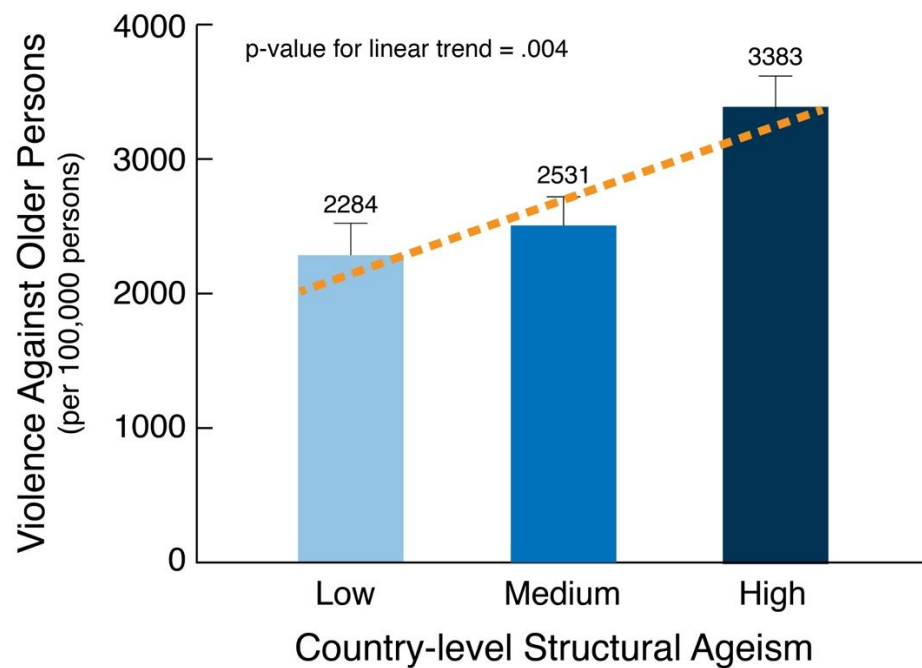
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Figure 1. Higher structural ageism is associated with greater prevalence rates of violence against older persons.

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eTable 1. Country-Level Structural Ageism and Prevalence Rates of Violence Against Older Persons in 56 countries

Country	Structural Ageism	Prevalence *Rates of violence per 100,000 persons*	Country	Structural Ageism	Prevalence *Rates of violence per 100,000 persons*
Algeria	3.0	1516.0	Morocco	4.0	1466.7
Argentina	2.5	2939.6	Netherlands	1.3	1570.2
Armenia	2.1	2658.0	New Zealand	1.6	3340.4
Australia	2.1	2968.4	Nigeria	7.3	3605.2
Azerbaijan	1.4	3065.7	Pakistan	4.8	2370.4
Belarus	5.5	4348.2	Peru	3.2	1699.5
Brazil	2.0	2502.5	Philippines	4.3	4445.2
Chile	2.1	2575.1	Poland	3.3	2336.9
China	4.5	7109.6	Qatar	1.7	1729.5
Columbia	3.4	3316.0	Romania	4.3	2601.5
Cyprus	0.3	1783.4	Russia	3.1	5300.1
Ecuador	2.8	2534.2	Rwanda	5.3	4147.4
Egypt	3.6	1271.0	Singapore	3.9	1331.7
Estonia	3.5	4287.0	Slovenia	4.2	2639.6
Georgia	2.9	2233.8	South Africa	5.0	4481.1
Germany	2.7	1329.5	South Korea	2.5	1446.8
Ghana	5.4	2962.3	Spain	0.4	1554.4
Haiti	4.3	3558.5	Sweden	1.6	1913.8
Iraq	4.8	2009.2	Thailand	3.9	3312.5

Japan	1.6	1642.6	Trinidad and Tobago	2.7	2723.7
Jordan	2.6	1738.3	Tunisia	4.3	1506.3
Kazakhstan	3.5	3238.2	Turkey	3.9	1747.6
Kuwait	4.1	1605.9	Ukraine	4.4	4647.7
Kyrgyz Republic	3.0	2815.9	Uruguay	4.4	2818.6
Lebanon	7.2	1610.9	United States	2.6	4031.8
Libya	4.2	1501.1	Uzbekistan	0.0	2331.1
Malaysia	2.8	2805.2	Yemen	2.5	1392.6
Mexico	2.7	3404.4	Zimbabwe	4.2	5082.5

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	7-11
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	7-11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-11
Bias	9	Describe any efforts to address potential sources of bias	7-11
Study size	10	Explain how the study size was arrived at	7-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10-11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	10-11

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(*e*) Describe any sensitivity analyses

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Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	12
		(c) Consider use of a flow diagram	12
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12-13
		(b) Indicate number of participants with missing data for each variable of interest	12-13
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	*12-13*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	*12-13*
		(*b*) Report category boundaries when continuous variables were categorized	*12-13*
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	*12-13*
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	*12-13*

Discussion

Key results	18	Summarise key results with reference to study objectives	13-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-15

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Impact of Structural Ageism on Greater Violence Against Older Persons: A Cross-National Study of 56 Countries

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Impact of Structural Ageism on Greater Violence Against Older Persons:

A Cross-National Study of 56 Countries

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Abstract

Objective: To determine the association between country-level structural ageism and prevalence of violence against older persons.

Design: Country-level ecological study.

Setting: Structural ageism data were drawn from the nationally-representative World Values Survey 2010-2014 (WVS), global databases from the World Health Organization (WHO), United Nations (UN), and the World Bank. Violence data were based on the Global Burden of Diseases Study 2017 (GBD).

Participants: Analysis of 56 countries that represented 63.1% of the world's aging population aged 60 and over across all six of WHO regions.

Exposure: Structural ageism, following established structural stigma measures, consisted of two components: (1) discriminatory national policies related to older persons' economic, social, civil, and political rights, based on the four core components of human rights protection in Madrid International Plan of Action on Aging; and (2) prejudicial social norms against older persons, measured by negative attitudes toward older persons in 56 national polls in WVS aggregated to country-level. These components were z scored and combined such that higher score indicated greater structural ageism.

Main Outcomes and Measures: Prevalence rates of violence per 100,000 persons aged 70 and over in each country was based on extensive epidemiological surveillance data, survey, clinical data, and insurance claims in GBD and compiled by the Institute of Health Metrics and Evaluation, University of Washington.

Results: There was a wide variation in levels of structural ageism across countries. As predicted, structural ageism was significantly associated with the prevalence rates of violence in

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multivariate models (β =205.7, SE=96.3, *P*=.03), after adjusting for relevant covariates.

Sensitivity analyses supported the robustness of our findings. That is, structural ageism did not

predict other types of violence and other types of prejudice did not predict violence against older

persons.

Conclusions: This study provides the first evidence of the association between higher structural

ageism and greater violence against older persons across countries.

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Strengths and Limitations of this study

- The current study, which is based on 56 countries that represented 63.1% of the world's aging population aged 60 and over across all six of WHO regions, is one of the largest cross-national investigations on violence against older persons to date.

- The ecological analysis examines a previously unexplored link between structural ageism and violence against older persons.

- A strength of our investigation was it examined country-level structural ageism for the first time by combining social norms and laws; this methodologically-validated approach was informed by extensive scholarship on other types of structural stigma including of women and sexual minorities.

- The robustness of the structural ageism- violence linkage was supported by three additional sets of sensitivity analyses.

- The ecological design with country-level information could be strengthened by adding individual-level data.

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Introduction

Violence directed against older persons is a pervasive public health problem. Globally, prevalence of violence against older persons has increased significantly over the last two decades.[1] One in six older persons experiences elder abuse in the past year.[2] Older persons' safety may be particularly compromised during the current COVID-19 pandemic as they experience increased exposures to wide-spread age-based discrimination, social isolation with perpetrators, and reduced options for support.[3] The associated social, psychological, and financial stressors further present significant barriers for reporting and help-seeking.[4] To this end, the United Nations has called for improved protection for older persons' safety and well-being during this health crisis. [5]

Addressing violence against older persons require population-level solutions. The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have strongly recommended the integration of a socio-ecological framework in violence prevention research and practice.[6] Based on this multi-level model, risk factors for violence against older persons operate across individual, relationship, community and societal levels of social ecology, that jointly place individuals at a higher risk of violence victimization and perpetration. However, the majority of research on violence against older persons pertain to individual factors.[7] Compounding this lack of evidence beyond individuals is the disproportionate focus on the deficits of victims that erroneously suggests victims are to be blamed.[8]

Societal-level risk factors in violence against older persons deserve more attention given that interventions could be most effective when context-changing strategies are in place.[9] This knowledge void may be owing to a few conceptual, measurement, and methodological challenges. While contexts shape interactions, existing theories have largely overlooked the

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ways in which macro-level factors, such as policies and cultural norms specific to aging, may be linked to downstream individual behaviors. Additionally, cross-national comparisons are lacking in this line of research.[7] With data typically collected in a single country, participants' responses may be restricted by the particular cultural climate in that country, hence limiting the understanding of the role of societal determinants on violence victimization and perpetration across cultures.[10]

As the most widespread form of bias and prejudice,[11,12] ageism harms older persons' health simultaneously at both structural and individual levels. At the structural level, ageism is manifested in the forms of explicit and implicit policies, practices, or social norms that impose bias and discrimination against older persons. At the individual level, ageism is manifested by negative age stereotypes and negative self-perceptions of aging. As premised by the Stereotype Embodiment Theory (SET),[13] both levels are closely intertwined because individual-level ageism is assimilated by older persons from surrounding cultures that propagate structural ageism. A recent systematic review based on 7 million older participants across 25 years found evidence the injurious health effects of structural ageism existed across country borders, but none of the studies included examined violence against older persons as its health outcome.[14]

There are strong theoretical and empirical evidence from parallel tracks of stigma and violence research against women and sexual minorities to suggest the potential link between structural ageism and violence against older persons.[15] As suggested by SET, a plausible psychological pathway may be that ageism operating at the structural level could trickle down to shape individuals' negative age beliefs, which in turn affect behavioral outcomes.[13] Additionally, one might postulate that in social contexts that denigrate a group, individuals tend to be more accepting of violence toward that group. For instance, research in family violence

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has found that cultures with greater sexism exhibited higher tolerance of intimate partner violence.[16,17]

Last, considering structural ageism embodies a sociopolitical climate that disempower older persons, the embedded hierarchical power relations may also leave older persons with less resources to protect themselves from violence and its associated risk factors. However, until now, the assumed link between structural ageism and violence had not been tested.[18,19]

In this present study, we predicted that structural ageism would be associated with greater prevalence of violence against older persons, after adjusting for socioeconomic and health risk factors.

Methods

Data Sources

Data for our predictor, structural ageism, were drawn from the latest available wave of World Values Survey (WVS) in 2010-2014 and global health databases including the World Health Organization (WHO) and United Nations (UN). The WVS consists of nationally representative polls of individuals' attitudes and behaviors since 1981.[20] Outcome data on the prevalence estimates of violence were drawn from the Global Burden of Disease Study (GBD) in 2017 compiled by the Institute of Health and Metrics Evaluation (IHME) at the University of Washington.[21] Data sources for covariates included WHO and the World Bank. Countries that had data for structural ageism measures and prevalence estimates for violence formed our final analyses, which was consisted of 56 countries representing 82,249 respondents in WVS.[20] Together, these countries accounted for 63.1% of the global older population aged 60 years and older, representing all six WHO regions.

Exposure: Structural Ageism

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To operationalize structural ageism, we followed a methodologically-validated approach

informed by extensive scholarship on structural stigma, which includes discriminatory social

policies and prejudicial social norms.[22-24] Discriminatory social policies referred to macro-level

policies and practices that discriminate against or restrict the resources and opportunities for

older persons. In order to match with prejudicial social norms that were measured between 2010

to 2014 in the WVS, the presence of four policies between 2010 to 2014 selected for the present

index reflected four core components of human rights protection in the Madrid International Plan

of Action on Aging[25], including economic, social, civil, and political rights.[26] As the most

comprehensive international policy framework to address population aging,[27] the Madrid Plan

strives to eliminate all forms of violence and discrimination against older persons.[26] In our

index, the protection of economic rights was based on whether or not each country had enacted

pension reform laws including raising retirement benefits of workers as initially reported by

country, and then subsequently validated and reported by UN experts in UN's World Population

Policies database.[28] The protection of social rights - or recognizing older persons as a social

group deserving of their own rights, was assessed by coding the presence of national policies that

included healthy aging as a priority policy. Each country self-reported whether or not they have

developed laws to protect the well-being of their aging populations. Data were collected and

compiled by United Nations Population Fund (UNFPA).[29] The protection of civil rights was

based on the existence of employment non-discrimination policies for older workers, drawn from

expert evaluation in the publicly available Employment Protection Legislation Database, UN's

International Labor Organizations.[30] The protection of political rights was based on the

existence of constitutional-level protection against age discrimination, reported by each country

and compiled by UNFPA.[29]

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The absence or presence of each of these 4 policies were summed into a continuous variable, ranging from 0 to 4. Higher score indicated that a country had greater structural ageism, as indicated by fewer policies protecting older persons. Overall, 17.9% had one discriminatory policy, 42.9% had two discriminatory policies, 16.1% had all four indicators of discriminatory policies. Only one had zero (Spain) (see table 1 in the Supplement).

The second domain in our index pertains to societal-level prejudicial attitudes toward older persons that reflects overarching public opinions.[24,31] Participants in WVS were asked their level of agreement on "older persons are a burden on society." Score ranged from 1 to 4, with high levels indicated higher level of burden. The mean value was aggregated at the country-level. Higher values indicate more prejudicial social norms against older persons. Mean (SD) was 1.8 (0.2) that ranged from 1.2 to 2.4. Overall, 45.0% of all countries reported above-average level of endorsement in this statement.

Following analytical procedures in creating structural stigma indices,[32,33] we standardized the scores for each of the two domains separately, and then summed up both z-transformed score to create the structural ageism index. Given the values ranged from negative to positive in standardized scores, to ease interpretation, we added the positive value of the lowest negative value across all scores, so that the final scores would be equal or larger than 0. A separate factor analysis showed that both domains loaded on the same factor (eigenvalues>1.0; factor loading= .74), suggesting one underlying latent factor supporting the composite structural ageism index.

Structural ageism was examined as a continuous variable in the bivariate and multivariable models. As a secondary analysis to quantify risk levels of structural ageism in

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relation to prevalence of violence, we operationalized structural ageism as a categorical variable

based on tertiles of final scores (i.e., low-, medium-, and high-level of structural ageism).

Outcome: Prevalence Estimates of Violence against Older Persons

We obtained prevalence estimates of violence from the Global Burden of Disease Study

(GBD), one of the most comprehensive cross-national epidemiological studies on injuries,

morbidities, and mortality based on extensive survey, epidemiological surveillance, and clinical

data sources.[21] Recent reiteration of GBD was conducted by the Institute for Health Metrics and

Evaluation (IHME) at the University of Washington using Bayesian meta-regression model to

estimate rates of prevalence for each health and injury domain. In 2017, GBD was based on

68,781 data sources used for the analysis of nonfatal causes of disease and injury for a total of

354 causes.[21] Estimates were presented for those 70 and over which we used within each of the

56 countries. GBD defined interpersonal violence according to the International Classification

of Diseases (ICD)-10 (X85-Y08.9, Y87.1)[34] that covered three categories: (1) physical assault by

any means, including firearm, bodily force, sharp or blunt objects, (2) sexual assault by bodily

force, and (3) mistreatment, neglect, and abandonment, including physical abuse, sexual abuse,

torture and cruelty. The prevalence of violence victimization used in this study was prevalence

rate of both fatal and non-fatal violence victimization per 100,000 persons in the age group of 70

years and over that covered all three categories of interpersonal violence. Although not yet

applied to violence against older persons, prevalence estimates of violence drawn from GBD

have been applied in systematic cross-national analysis of other forms of violence including

intimate partner violence and suicides. [35]

Country-level Covariates

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We considered a wide range of socio-demographic and health variables as potential covariates a priori, owing to their known relationships with violence.[15,36-40] The pool of potential covariates, assessed in 2010 to match with the timing of the predictor, included (1) population ratio, measured by the proportion of the population 70 years and older relative to that of the younger-age population (20-69), (2) gross national income (GNI) per capita (in 1,000 international dollar increments), (3) average years of schooling, (4) unemployment rate, and (5) alcohol consumption per capita. These covariates were available for all of the 56 countries.

To maintain study power and create the most parsimonious model, final covariates were selected based on the backward elimination strategy with the significant level set at p<.10. We performed a backward selection stepwise regression model in accordance with the Akaike Information Criterion (AIC), a measure of model deviance adjusted for the parameters in the model.[41] This approach with stepwise regression models was commonly applied in previous country-level ecological studies of violence with relatively smaller sample sizes. [42,43] Based on this variable selection procedure, three covariates were selected and thus retained in the final multivariable model: population ratio, GNI per capita, and alcohol consumption per capita.

Statistical Analysis

Pearson correlation coefficients were used to examine the association between structural ageism, violence prevalence estimates, and covariates. Bivariate and multivariable linear regression models were used to estimate the relationship between structural ageism and prevalence rates of violence. Goodness of fit of the models to the data was evaluated using AIC. We used residual plots and multi-collinearity diagnostics to examine issues of heteroscedasticity

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and multi-collinearity. To evaluate potential outliers in the model, we examined whether any

observations was more than one Cook's distance.[44]

To examine the robustness of the findings, we conducted several additional sensitivity

analyses. First, to examine the discriminant validity of the structural ageism index, analyses of

were performed replacing the prevalence rates of violence in older age groups with the estimates

of violence in children in the forms of violent disciplines and peer violence. We hypothesize that

structural ageism would not be related to estimates of violence in children. Data were drawn

from nationally representative surveys in the UNICEF global databases.[45] Violent discipline by

caregivers included psychological aggression, physical, and corporal punishment, as measured

by the Parent-Child Conflict Tactics Scale.[46] Peer-violence was measured by the proportion of

students aged 13-15 years who reported being bullied on one or more days in the past 30 days.

The number of countries that had available estimates of violent discipline and peer violence

during years of 2014-2017 that matched with participating countries in WVS were 19, and 21,

respectively.

The second sensitivity analysis examined the predictive validity of the structural ageism

index by assessing the relationship between anti-immigrant, racial prejudice and prevalence

estimates interpersonal violence in older age. We hypothesize that anti-immigrant and racial

prejudice attitudes would not be related to interpersonal violence in older age. Anti-immigrant

and racial prejudice attitudes were drawn from the WVS. Participants were asked to state which

groups they would not like to have as neighbors: "People of another race," or

"Immigrants/foreign workers." This measure has been used to assess negative attitudes toward

minority group members.[47,48]

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The third sensitivity analysis examined whether the effects of structural ageism on violence prevalence estimates were only specific to older age groups, but not younger age groups. Based on GBD 2017, we obtained prevalence rates of violence in age 15 to 49 years old.

All analyses were conducted in SAS (version 9.4, SAS Institute Inc., Cary, NC). This study was exempted by Yale University's Institutional Review Board (IRB2000027318).

Patient and public involvement

Neither patients nor the public were involved in this research.

Results

As predicted, structural ageism was significantly associated with higher prevalence of violence against older persons. This was found in both bivariate (β =261.0, SE=106.0, P=.02). and multivariable models (β =205.7, SE=96.3, P=.03). After controlling for covariates, a one standard deviation increase in the structural ageism index was associated with a 205.7 per 100,000 persons increase in the prevalence of violence against older persons aged 70 years and older. Also as predicted, in a secondary analysis that included the categorization of the low-, medium-, and high- structural ageism predictor, there was a linear pattern between increasing levels of ageism and higher prevalence rates of violence, after adjusting for covariates (test for linear trend: P = .02) (figure 1).

With respect to model diagnostics, collinearity tests indicated no evidence of multicollinearity.[49] Residual plots confirmed the model assumptions (normality and homoscedasticity of residuals) were met. All but two cases (China and Qatar) had a larger than Cook's Distance cut-off of one for outliers. When we removed China and Qatar respectively from the multivariable model estimates, the positive association between structural ageism and prevalence remained significant.

Our results showed wide variation in levels of structural ageism across countries, with higher value indicating greater structural ageism (total values ranged from 0 to 7.3) (table 1). Nigeria, Lebanon, and Belarus reported highest structural ageism. Uzbekistan, Cyprus, and Spain had the lowest structural ageism. China, Russia, and Zimbabwe had the highest prevalence rates of violence against older persons; whereas Singapore, Germany, and Egypt had the lowest prevalence rates of violence against older persons. In support of this index, the scoring of structural ageism in this study significantly correlated with a recent parallel report that ranked country-level ageism based on social indices of five domains, including economic, health, employment, environment, and social participation, across 15 Organization for Economic Corporation and Development (OECD) countries (R=0.59, P=0.02).[50]

Results from three sensitivity analyses suggested the robustness of the results. First, in support of the discriminant validity of structural ageism index, ageism was not correlated with violent discipline (R=0.31, P=.21) or bullying (R=-0.13, p=.59). Second, in support of the predictive validity of structural ageism index, anti-immigrant and racial prejudice were not correlated with violence estimates against older persons (R= -0.18, P=.20; R= -0.17, P=.20; respectively). Third, the relationship between structural ageism and violence was non-significant in the younger age group of 15 to 49 years old, suggesting the validity of our findings.

Discussion

This study investigated a previously unexplored relationship between structural ageism and violence against older persons. As predicted, we found that structural ageism is significantly associated with prevalence rates of violence against persons aged 70 and over, after controlling for known risk factors.   Our findings suggest a comprehensive strategy for preventing violence against older persons should include structural ageism.

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Public health research on improving support structures and societal-based solutions is

needed to effectively prevent violence against older persons at a large scale, especially in times

of unrest and relative instability. A recent CDC report estimated that the rate of nonfatal assaults

against persons 60 years and older has risen by 53% between 2008 and 2016.[51] Additionally,

recent reports have indicated increasing rates of interpersonal violence in family settings during

the ongoing COVID-19 pandemic.[52] As psychological stressors continue to intensify during the

ongoing pandemic as the consequences of self-quarantine, expanding structural-level program

response to improve the safety of older persons would be essential.

A strength of our investigation was it examined country-level structural ageism

combining social laws and norms. The wide variation in country-level attitudes toward older

persons was in line with previous cross-cultural analyses.[53,54] In the domain of policies, we also

found variation in the level of each country's protection toward older persons. This may be a

reflection of the gap in existing legal provisions and international conventions specifically

supporting the rights of older persons.[55]

Congruent with intersectional theories,[56] our findings showed that countries reported

higher structural ageism coincided with those that also reported greater inequality in other realms

of stigma. For instance, Nigeria ranked among the highest in structural ageism in this study as

well as highest in structural stigma against sexual minorities in a recent cross-cultural study of

197 countries.[57] The opposite estimate was found in Spain where it ranked among the lowest in

both structural stigma measures. Parallel scholarship in gender-based stigma also recently found

that women residing in countries with greater structural-level gender-based stigma were more

likely to experience violence.[58] Indeed, both older age and female gender could be potential

modifying factors in the association between ageism and violence. As structural systems of

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oppression are often mutually manifested to reinforce health inequalities, analyses that only focus on gender, race, ethnicity alone are insufficient to understand population-level health disparities.[59] Future multi-level analyses that combine both population level and individual level data may assist in addressing the examination of these intersectional axes between older age, sex, and structural stigma in predicting violence.

Integrating structural ageism as a societal-level risk factor in existing elder abuse research may also help inject a multi-systemic, socio-cultural lens in developing much-needed interventions.[60] Theories of elder abuse have been predominantly interpersonal in nature, where victims of abuse were typically described as uniformly dependent and powerless.[61-63] The emphasis on older persons' vulnerabilities is not only a form of victim-blaming, but also shifts our attention away from the broader status inequality that each individual is embedded in. Considering the ways in which structural ageism seep through social interactions and its downstream consequences in shaping the inherent power imbalance between victims, perpetrators, and their environments can offer promising opportunities for primary prevention strategies.[64]

Our findings have a few limitations that point to future research directions. First, given that violence in general and elder abuse in particular is stigmatizing and illegal in most of the countries, it is possible that the violence against older person was under-reported. Second, the current ecological study design did not allow us to produce casual inference between structural ageism and violence against older persons. However, there are two reasons that we consider it likely that greater structural ageism led to greater risk of violence. First, it does not seem likely that the reverse of a diagnostic health outcome would influence a structural-level variable. Second, to ascertain temporal association, our structural ageism variable was based on estimates

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in 2010-2014, that predated violence prevalence outcome in 2017. Last, although we used global data with consistent definitions that allows for cross-national comparisons, the aggregate data structure would not permit individual-level interpretation. Future investigations should further assess whether the observed structural ageism-violence linkage extends to the individual level.

As one of the largest cross-country studies on violence against older persons to date, this study also has a number of methodological strengths including: mitigating data variability for cross-country violence prevalence estimates with various data processing and estimation techniques as employed by GBD study investigators [21]; following strict definition of interpersonal violence guided by ICD diagnostic codes; and developing and implementing the first structural ageism measure combining social norms and laws.

Our findings hold important implications for violence prevention programming. First, ageism that operates at both individual and structural level deserves more consideration in estimating the occurrence of violence and abuse in older persons. Second, social and legal policies are inherently public health policies.[65] Social policies that protect the rights of older persons may reap significant public health benefits for population-level violence preventions. Third, as existing approaches for violence preventions are tailored toward individual ecology, positioning structural ageism as a societal risk factor of violence against older persons may help catalyze a paradigm shift in refining current primary preventions against violence and abuse. Such structural approach may focus on reducing ageism through improving political-legal, economic, as well as intergenerational support for older persons.[66] Other ways that policy makers and public health officials can mitigate effects of structural ageism could be by establishing societal-wide campaigns that promote older persons' rights and enhance diverse representation of aging through social media.[67]

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Conclusion

Our results suggest that structural ageism is a social determinant of elder abuse. Public

health and population-based violence prevention policies may benefit from a targeted approach

that tackles the harmful effects of structural ageism.

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Contributors

EC was involved in study conceptualization and design, data collection, analyses, interpretation

of results and manuscript writing. JM and DZ contributed to study design, analyses and

manuscript writing. BL contributed to study conceptualization and design, supervised analyses,

and contributed to interpretation of results and manuscript writing.

Competing Interests

None

Funding Statement

Ethics Approval

This study was exempted by Yale University's Institutional Review Board (IRB2000027318).

Data Sharing Agreement

Data relevant to the study are included in the article or uploaded as supplementary information

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Figure 1. Higher structural ageism is associated with greater prevalence rates of violence against older persons.

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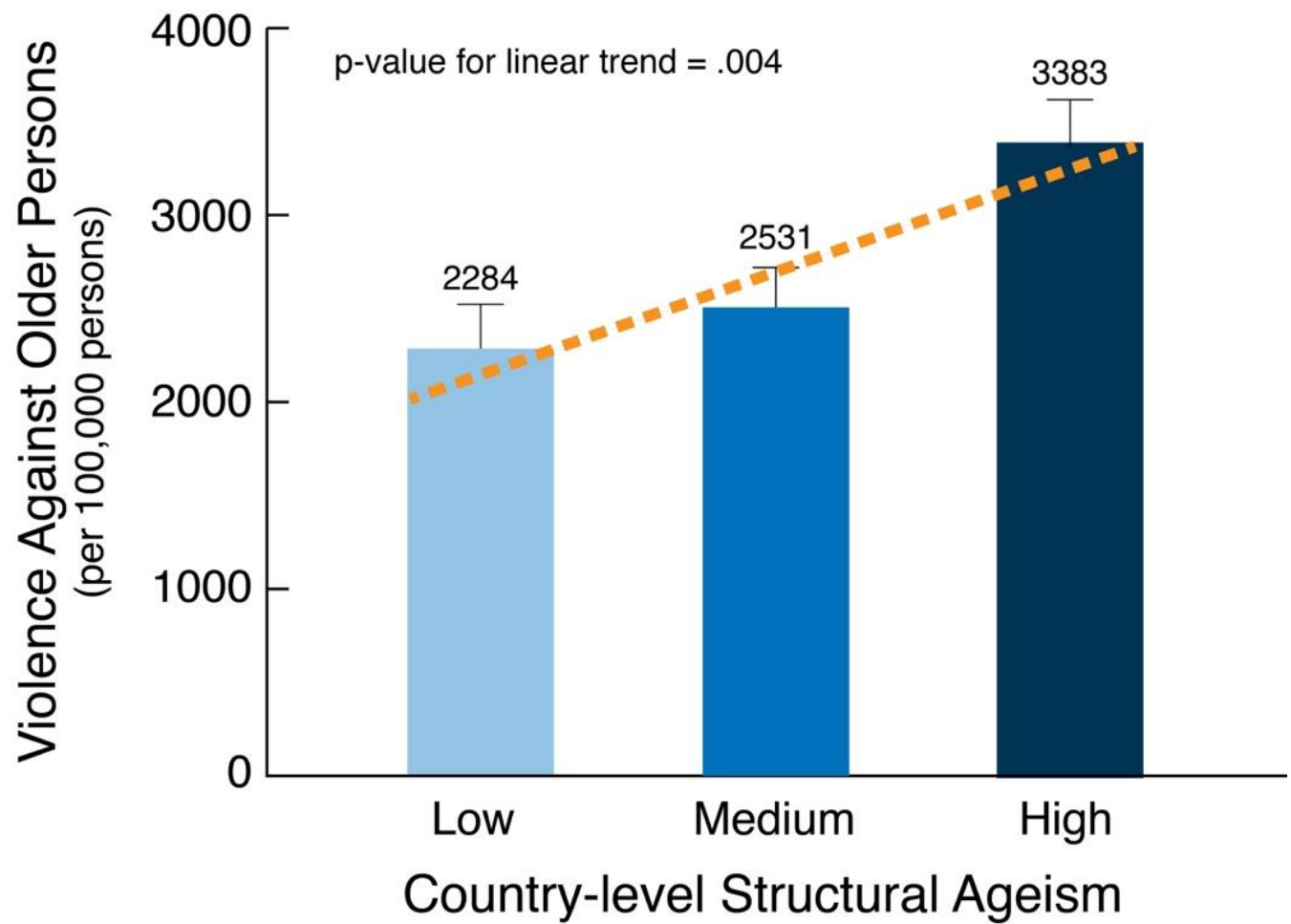
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Figure 1. Higher structural ageism is associated with greater prevalence rates of violence against older persons.

eTable 1. Country-Level Structural Ageism and Prevalence Rates of Violence Against Older Persons in 56 countries

Country	Structural Ageism	Prevalence Rates of violence per 100,000 persons	Country	Structural Ageism	Prevalence Rates of violence per 100,000 persons
Algeria	3.0	1516.0	Morocco	4.0	1466.7
Argentina	2.5	2939.6	Netherlands	1.3	1570.2
Armenia	2.1	2658.0	New Zealand	1.6	3340.4
Australia	2.1	2968.4	Nigeria	7.3	3605.2
Azerbaijan	1.4	3065.7	Pakistan	4.8	2370.4
Belarus	5.5	4348.2	Peru	3.2	1699.5
Brazil	2.0	2502.5	Philippines	4.3	4445.2
Chile	2.1	2575.1	Poland	3.3	2336.9
China	4.5	7109.6	Qatar	1.7	1729.5
Columbia	3.4	3316.0	Romania	4.3	2601.5
Cyprus	0.3	1783.4	Russia	3.1	5300.1
Ecuador	2.8	2534.2	Rwanda	5.3	4147.4
Egypt	3.6	1271.0	Singapore	3.9	1331.7
Estonia	3.5	4287.0	Slovenia	4.2	2639.6
Georgia	2.9	2233.8	South Africa	5.0	4481.1
Germany	2.7	1329.5	South Korea	2.5	1446.8
Ghana	5.4	2962.3	Spain	0.4	1554.4
Haiti	4.3	3558.5	Sweden	1.6	1913.8
Iraq	4.8	2009.2	Thailand	3.9	3312.5
Japan	1.6	1642.6	Trinidad and Tobago	2.7	2723.7
Jordan	2.6	1738.3	Tunisia	4.3	1506.3
Kazakhstan	3.5	3238.2	Turkey	3.9	1747.6
Kuwait	4.1	1605.9	Ukraine	4.4	4647.7
Kyrgyz Republic	3.0	2815.9	Uruguay	4.4	2818.6
Lebanon	7.2	1610.9	United States	2.6	4031.8
Libya	4.2	1501.1	Uzbekistan	0.0	2331.1
Malaysia	2.8	2805.2	Yemen	2.5	1392.6
Mexico	2.7	3404.4	Zimbabwe	4.2	5082.5

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	7-11
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	7-11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-11
Bias	9	Describe any efforts to address potential sources of bias	7-11
Study size	10	Explain how the study size was arrived at	7-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10-11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	10-11

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(*e*) Describe any sensitivity analyses

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Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	12
		(c) Consider use of a flow diagram	12
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12-13
		(b) Indicate number of participants with missing data for each variable of interest	12-13
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	*12-13*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	*12-13*
		(*b*) Report category boundaries when continuous variables were categorized	*12-13*
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	*12-13*
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	*12-13*

Discussion

Key results	18	Summarise key results with reference to study objectives	13-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-15

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.