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Original research article

Population patterns of temporal orientation in older adults: a cross-national analysis of SHARE Wave 9 in Central Europe

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Abstract

Background: Temporal orientation is a brief cognitive indicator widely used in clinical and population-based assessments. Impaired temporal orientation has been associated with functional decline and increased care needs, yet population-level evidence from Central Europe remains limited.

Objectives: This study examined patterns of temporal orientation among adults aged 50 years and older in the Visegrád Four countries.

Methods: Cross-sectional data from SHARE Wave 9 were analysed. Temporal orientation was assessed using four standard items and summarised as a total score and a binary indicator (perfect vs. non-perfect orientation). Ordinal and binary logistic regression models were fitted, adjusting for age, educational attainment (ISCED-97), gender, and country. Item-level analyses were also performed.

Results: Increasing age was consistently associated with lower odds of perfect temporal orientation, while higher educational attainment showed a robust protective effect. Men had moderately lower odds of perfect orientation compared to women. Significant country differences were observed, primarily driven by performance on the "day of the month" item.

Conclusion: Despite pronounced ceiling effects, temporal orientation captures meaningful population-level gradients. As a low-burden indicator, it may support the identification of cognitively vulnerable groups in ageing populations, without replacing comprehensive diagnostic assessment.

Keywords: Cognitive ageing; Population-based study; SHARE; Temporal orientation

Introduction

Population ageing across Europe is accompanied by increasing clinical, care-related, and public health challenges associated with cognitive functioning in later life. Although the diagnosis of dementia and mild cognitive impairment requires comprehensive neuropsychological assessment, brief cognitive indicators are increasingly applied in everyday care and population-based surveillance as early markers of cognitive vulnerability (Livingston et al., 2020; Tsoi et al., 2015).

Temporal orientation, defined as the ability to identify basic temporal information, is among the most widely used indicators due to its low burden and feasibility in large-scale settings. It is routinely included in cognitive screening instruments such as the Mini-Mental State Examination (Folstein et al., 1975). Although deficits in temporal orientation do not constitute a standalone diagnosis, existing literature highlights their correlation with more extensive cognitive deterioration, functional dependency, and an escalated demand for care services. Furthermore, longitudinal data underscore the predictive significance of such impairments in tracking disease progression (Guerrero-Berroa et al., 2009; Harada et al., 2013).

From a public health perspective, temporal orientation assessments offer a streamlined method for identifying socio-demographic disparities in cognitive health. The natural senescence process entails a progressive attenuation of cognitive faculties, a trend clearly reflected in temporal orientation performance (Salthouse, 2019). High levels of formal education appear to exert a protective influence on cognitive trajectories. This observation aligns with the cognitive reserve hypothesis, which posits that educational attainment enhances the brain's resilience against age-related neurocognitive decline, thereby delaying the clinical manifestation of impairment (Fjell et al., 2025; Stern, 2002, 2012).

Gender differences in later-life cognitive outcomes have also been reported, although their magnitude is generally modest and strongly influenced by social context (Mielke et al., 2014).

Cross-national differences in temporal orientation are likely to reflect not only individual-level factors but also broader differences in health status, educational systems, prevention

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strategies, and elderly care contexts (Prince et al., 2015; WHO, 2023). The Visegrád Four countries provide a relevant comparative framework in this respect, combining geographical proximity and shared historical features with distinct health and social system trajectories.

The harmonised design of the Survey of Health, Ageing and Retirement in Europe (SHARE) enables temporal orientation to be analysed as a simple and internationally comparable indicator in population-based studies (Bergmann et al., 2024; Börsch-Supan et al., 2013). However, simple cognitive measures are frequently affected by ceiling effects, which pose methodological challenges and support the use of complementary analytical approaches, including ordinal, binary, and item-level analyses (Crane et al., 2006; Teresi and Fleishman, 2007).

Within this framework, the present study treats temporal orientation not as a diagnostic instrument but as a population-level marker of cognitive vulnerability, aiming to assess its ability to capture social gradients and country-specific differences among older adults.

Study aims and research questions

The aim of this study is to examine population patterns of temporal orientation as a rapidly measurable, low-burden cognitive indicator using SHARE Wave 9 data from adults aged 50 years and older in the Visegrád Four countries. The analysis focuses on both aggregate and item-level indicators of temporal orientation and their associations with age, educational attainment, gender, and country context.

Specifically, the study addresses whether temporal orientation is affected by a pronounced ceiling effect, whether consistent age-, education-, and gender-related gradients are observable, and whether country differences persist after adjustment for key demographic factors. In addition, the analyses explore whether observed differences are concentrated at the aggregate level or within specific components of temporal orientation.

Materials and methods

Study design and data source

This cross-sectional investigation uses data derived from the ninth wave of the Survey of Health, Ageing and Retirement in Europe (SHARE), a multi-national, population-based initiative targeting individuals aged 50 and above (Bergmann et al., 2024; Börsch-Supan et al., 2013; SHARE-ERIC, 2024). Fieldwork for Wave 9 was conducted between 2021 and 2022, adhering to rigorous interviewer protocols and harmonised data processing standards. The current study focuses specifically on the Visegrád Four (V4) nations – the Czech Republic, Poland, Hungary, and Slovakia – owing to their regional proximity and the availability of a robust sample size for population-level inferences.

Study population

From an initial pool of 69,447 SHARE Wave 9 participants, the V4 subsample originally comprised 11,030 individuals. Eligibility was restricted to respondents aged 50 years or older. Following the exclusion of cases with incomplete age records, the final analytical cohort consisted of 10,950 participants. The proportional distribution across the four countries (Poland, the Czech Republic, Hungary, and Slovakia) remained consistent after applying the age filter, ensuring the integrity of subsequent cross-national comparisons.

Temporal orientation

Cognition was assessed via the SHARE module, focusing on four specific domains: day of the month, month, year, and day of the week. These items were aggregated into a composite score (ORIENT, 0–4), where higher values signify superior cognitive performance. To account for the substantial ceiling effect observed in the raw scores, a dichotomous indicator (ORIENT_BIN) was established, distinguishing "perfect performance" (score of 4) from "any error" (score <4). Furthermore, each component was scrutinised individually as a binary outcome.

Socio-demographic predictors

The analytical framework considered age as a continuous measure (expressed in years), while gender was treated as a categorical variable, with women as the reference group. Educational attainment was categorised according to the ISCED-97 classification and integrated into the models as an ordinal trend component. Furthermore, the geographical context was represented by the country of residence of the participants (Czech Republic, Poland, Hungary, and Slovakia); to facilitate comparative assessment, Slovakia was designated as the baseline reference category in all regression analyses.

Statistical framework

To delineate sample characteristics and the distribution of orientation markers, descriptive statistics were calculated. Inter-country disparities were evaluated through chi-square tests for categorical parameters and analysis of variance (ANOVA) for continuous variables. In instances where the assumption of homoscedasticity was violated, robust procedures were employed.

To model temporal orientation (0–4), ordinal logistic regression was primarily used. Given the skewed distribution and potential sparse category issues, the proportional odds assumption was rigorously evaluated. To ensure the reliability of the estimates, a binary logistic regression model (ORIENT_BIN) was implemented, adjusting for age, educational background (ISCED-97), gender, and country of residence (with Slovakia serving as the reference category). Model performance was gauged through likelihood ratio tests and pseudo-R^2 metrics. Item-level analyses incorporated Holm's correction for multiple comparisons, and the discriminative capacity of the binary models was validated using ROC curves and AUC values. Computational procedures were performed in IBM SPSS Statistics v24.0, applying a significance level of $p < 0.05$.

Results

Study population and regional distribution

The Visegrád Four (V4) subsample accounts for nearly 16% of the total sample of the ninth wave of the SHARE survey. After excluding those with missing age data and those under 50 years of age, the final sample was 10,950 people. Within this demographic group, the representation rates of Poland, the Czech Republic, Hungary, and Slovakia were maintained (Table 1). The application of age-specific criteria did not significantly distort the national rates, thereby strengthening the validity and generalisability of our regional comparative results.

Age profiles and comparative analysis

Within the V4 cohort aged 50 and above (n = 10,950), the mean age was 69.5 years (SD = 8.9; median = 69; range = 50–106), characterised by a near-symmetrical distribution and moderate dispersion. Age-related variability remained consistent across the four nations, with each subsample exhibiting an identical interquartile range of 12 years.

Statistically significant differences in mean age were observed between the participating countries. The Czech Republic presented the highest average age, whereas the lowest was recorded in Slovakia. A one-way analysis of variance (ANOVA) revealed a substantial global effect of nationality [$F(3, 10{,}946) = 122.19$, $p < 0.001$]. Due to the violation of variance homogeneity, this finding was further validated using the robust Welch procedure. Subsequent post-hoc evaluations indicated that the Czech population was significantly older than those of Poland, Hungary, and Slovakia. Conversely, the Slovak participants were significantly younger in comparison to both their Polish and Hungarian counterparts. No significant age difference was observed between Poland and Hungary.

Gender distribution

In the V4 sample, women constituted a higher proportion of respondents than men (58.2% vs. 41.8%). Gender distributions differed modestly across countries, with the lowest proportion of men observed in the Czech Republic and the highest in Slovakia (Table 1).

A statistically significant association was found between gender and country [Pearson's $\chi^2(3, N = 10{,}950) = 30.40$, $p < 0.001$], although the effect size was small (Cramer's V = 0.053), indicating limited practical relevance of these differences.

Table 1. Gender distribution by country (countries numbered according to the SHARE database)

Gender	Czech Republic 28	Poland 29	Hungary 32	Slovakia 63	Total
Male	1,250	2,080	775	477	4,582
	38.0%	43.4%	42.7%	45.3%	41.8%
Female	2,039	2,716	1,038	575	6,368
	62.0%	56.6%	57.3%	54.7%	58.2%
Total	3,289	4,796	1,813	1,052	10,950
	100.0%	100.0%	100.0%	100.0%	100.0%

Distribution of educational attainment (ISCED-97)

Educational attainment was assessed using ISCED-97 categories ($n = 10{,}908$ valid cases). Overall, ISCED-97 level 3 was the most prevalent category, followed by levels 2 and 5, while very low and very high education levels were relatively rare.

Educational distributions differed significantly across countries [Pearson $\chi^2(18, N = 10{,}908) = 632.13$, $p < 0.001$], with a small to moderate association strength (Cramer's V = 0.139). Country-specific patterns showed substantial variation in the concentration of educational levels, particularly the predominance of ISCED-97 level 3 in Slovakia and higher proportions of lower educational attainment in Poland (Table 2).

Table 2. Educational attainment distribution by country (countries numbered according to the SHARE database)

ISCED-97	Czech Republic 28	Poland 29	Hungary 32	Slovakia 63	Total
None	12	58	1	2	73
	0.4%	1.2%	0.1%	0.2%	0.7%
ISCED-97 code 1	203	367	10	12	592
	6.2%	7.7%	0.6%	1.1%	5.4%
ISCED-97 code 2	661	732	342	82	1,817
	20.2%	15.3%	18.9%	7.8%	16.7%
ISCED-97 code 3	1,787	2,790	1,048	878	6,503
	54.7%	58.3%	57.9%	83.5%	59.6%
ISCED-97 code 4	51	249	130	0	430
	1.6%	5.2%	7.2%	0.0%	3.9%
ISCED-97 code 5	540	571	276	72	1,459
	16.5%	11.9%	15.2%	6.9%	13.4%
ISCED-97 code 6	11	15	3	5	34
	0.3%	0.3%	0.2%	0.5%	0.3%
Total	3,265	4,782	1,810	1,051	10,908
	100.0%	100.0%	100.0%	100.0%	100.0%

Analysis of orientation indicators

The analysis of temporal orientation included 10,704 valid cases. The ORIENT score showed a pronounced ceiling effect, with 91.3% of respondents achieving the maximum value of 4, while lower scores were infrequent. Consistent with this distribution, the binary indicator (ORIENT_BIN) classified 91.3% of respondents as perfectly oriented and 8.7% as having at least one orientation error.

Temporal orientation distributions differed significantly across countries. The proportion of respondents with maximum ORIENT scores was lowest in the Czech Republic and highest in Slovakia, with intermediate values observed in Poland and Hungary (Table 3). These differences were statistically significant but small in magnitude [Pearson $\chi^2(12, N = 10{,}704) = 114.11$, $p < 0.001$; Cramer's V = 0.060].

Table 3. Distribution of the ORIENT (temporal orientation) variable by country (countries numbered according to the SHARE database)

ORIENT	Czech Republic 28	Poland 29	Hungary 32	Slovakia 63	Total
0	15	24	5	1	45
	0.5%	0.5%	0.3%	0.1%	0.4%
1	7	18	3	3	31
	0.2%	0.4%	0.2%	0.3%	0.3%
2	38	58	17	8	121
	1.2%	1.2%	1.0%	0.8%	1.1%
3	331	300	69	37	737
	10.3%	6.5%	3.9%	3.5%	6.9%
4	2,833	4,244	1,694	999	9,770
	87.9%	91.4%	94.7%	95.3%	91.3%
Total	3,224	4,644	1,788	1,048	10,704
	100.0%	100.0%	100.0%	100.0%	100.0%

Similar country patterns were observed for the binary ORIENT_BIN outcome (Table 4). The association between country and ORIENT_BIN was statistically significant [Pearson $\chi^2(3, N = 10{,}704) = 95.52$, $p < 0.001$], with a small effect size (Cramer's V = 0.094).

Table 4. Distribution of the ORIENT_BIN (temporal orientation binary) variable by country (countries numbered according to the SHARE database)

ORIENT_BIN	Czech Republic 28	Poland 29	Hungary 32	Slovakia 63	Total
0 (0–1–2–3)	391	400	94	49	934
	12.1%	8.6%	5.3%	4.7%	8.7%
1 (4)	2,833	4,244	1,694	999	9,770
	87.9%	91.4%	94.7%	95.3%	91.3%
Total	3,224	4,644	1,788	1,048	10,704
	100.0%	100.0%	100.0%	100.0%	100.0%

Ordinal regression model of the ORIENT variable

The ORIENT outcome (0–4) was analysed using ordinal logistic regression on 10,665 valid cases, with age, educational attainment (ISCED-97), gender, and country included as predictors (reference categories: female; Slovakia). The ORIENT distribution exhibited a strong ceiling effect, with a high proportion of sparse predictor combinations, necessitating cautious interpretation.

The full model significantly improved fit compared with the intercept-only model [LR $\chi^2(6) = 464.60$, $p < 0.001$], while pseudo-R^2 measures indicated low to moderate explanatory power (Nagelkerke $R^2 = 0.083$). The proportional odds assumption was violated [Test of Parallel Lines: $\chi^2(18) = 72.74$, $p < 0.001$].

Higher age was associated with lower odds of belonging to higher ORIENT categories [OR = 0.94, 95% CI (0.93–0.94)], whereas higher educational attainment showed a robust positive association [OR = 1.30, 95% CI (1.22–1.39)]. Compared with Slovakia, significantly lower odds of higher ORIENT categories were observed in the Czech Republic and Poland, while no difference was detected for Hungary. Male gender was associated with lower odds of higher ORIENT categories [OR = 0.77, 95% CI (0.67–0.88)] – Table 5.

Ordinal regression model of the ORIENT_BIN variable

An ordinal logistic regression model (PLUM; logit link) was fitted to ORIENT_BIN (4 vs. <4) using 10,665 valid cases (missing: 285). The outcome distribution was highly asymmetric (ORIENT_BIN = 1: 91.3%; ORIENT_BIN = 0: 8.7%) and sparse predictor combinations were present (31.7% zero-frequency cells). Therefore, model estimates and goodness-of-fit results were interpreted with caution.

Table 5. Parameter estimates of the ORIENT variable – ordinal logistic regression

	Estimate OR	Std. error	Wald	df	Sig.	95% Confidence interval OR	
						Lower bound	Upper bound
Age	0.94	0.004	246.841	1	0.000	0.93	0.94
isced1997	1.30	0.034	57.949	1	0.000	1.22	1.39
[country=28] CZ	0,49	0.158	20.192	1	0.000	0.36	0.67
[country=29] PO	0.62	0.157	9.054	1	0.003	0.46	0.85
[country=32] HU	0.98	0.182	0.009	1	0.926	0.69	1.40
[country=63] SK	0	.	.	0	.	.	.
[gender=1]	0.77	0.072	13.599	1	0.000	0.67	0.88
[gender=2]	0	.	.	0	.	.	.

The full model improved fit compared with the intercept-only model [LR $\chi^2(6) = 448.087$, $p < 0.001$], with low to moderate explanatory power (Cox–Snell $R^2 = 0.041$; Nagelkerke $R^2 = 0.092$; McFadden R2 = 0.071). Goodness-of-fit testing indicated no deviance-based fit problem [$\chi^2(1225) = 1159.986$, $p = 0.907$], whereas the Pearson statistic was significant [$\chi^2(1225) = 1481.279$, $p < 0.001$], consistent with sparse cells.

Higher age was associated with lower odds of perfect orientation [OR = 0.94, 95% CI (0.93–0.95), $p < 0.001$], while higher educational attainment increased the odds [OR = 1.29, 95% CI (1.21–1.39), $p < 0.001$]. Compared with Slovakia, lower odds of ORIENT = 4 were observed in the Czech Republic [OR = 0.48, 95% CI (0.35–0.65), $p < 0.001$] and Poland [OR = 0.62, 95% CI (0.46–0.85), $p = 0.003$], whereas Hungary did not differ [OR = 0.97, 95% CI (0.68–1.40), $p = 0.887$]. Male gender was associated with lower odds of ORIENT = 4 [OR = 0.77, 95% CI (0.67–0.89), $p < 0.001$] – Table 6.

Table 6. Parameter estimates of the ORIENT_BIN variable – ordinal logistic regression

	Estimate OR	Std. error	Wald	df	Sig.	95% Confidence interval OR	
						Lower bound	Upper bound
Age	0.94	0.004	225.360	1	0.000	0.93	0.95
isced1997	1.29	0.035	55.662	1	0.000	1.21	1.39
[country=28] CZ	0.48	0.159	21.627	1	0.000	0.35	0.65
[country=29] PO	0.62	0.158	9.076	1	0.003	0.46	0.85
[country=32] HU	0.97	0.183	0.020	1	0.887	0.68	1.40
[country=63] SK	0[a]	.	.	0	.	.	.
[gender=1]	0.77	0.072	13.212	1	0.000	0.67	0.89
[gender=2]	0a	.	.	0	.	.	.

Item-level examinations

Response completeness was high across all four orientation items (1.7–2.2% missing). Correct response rates were uniformly high, ranging from 92.5% for the day of the month item to 99.1% for the month item, with intermediate values for year (98.5%) and day of the week (97.9%), reflecting the pronounced ceiling effect observed for the aggregate ORIENT score.

Binary logistic regression models (correct vs. incorrect) were fitted for each item, including age, educational attainment (ISCED-97), gender, and country (reference: Slovakia). Sparse predictor combinations were present (33.7–46.7% zero-frequency cells), therefore model estimates and fit indices were interpreted with caution.

All four item-level logistic regression models were statistically significant [LR $\chi^2(6) = 106.48–435.99$, all $p < 0.001$], with modest explanatory power (Nagelkerke $R^2 = 0.086–0.140$). Increasing age was consistently associated with lower odds of a correct response across all items, while higher educational attainment showed a positive effect for each component, strongest for the year and day of the month items.

Country-specific effects varied by item. Compared with Slovakia, lower odds of correct responses for the day of the month item were observed in the Czech Republic and Poland, whereas Hungary did not differ. For the month item, only Hungary showed higher odds of correct responses, while no significant differences were observed for the Czech Republic or Poland. For the year item, lower odds were found in Poland and Hungary, with no significant difference in the Czech Republic. No significant country differences were detected for the day of the week item. Gender was not a consistent predictor at the item level and was non-significant across all components (Table 7).

Item-level summary (Holm correction)

After Holm correction, age remained a consistent and robust negative predictor of correct responses across all four orientation items (all $p < 0.004$), while higher educational attainment showed a stable positive association for each component. Country effects were item-specific and most pronounced for the day of the month item, where respondents from the Czech Republic and Poland had significantly lower odds of correct responses compared with Slovakia (both Holm-corrected

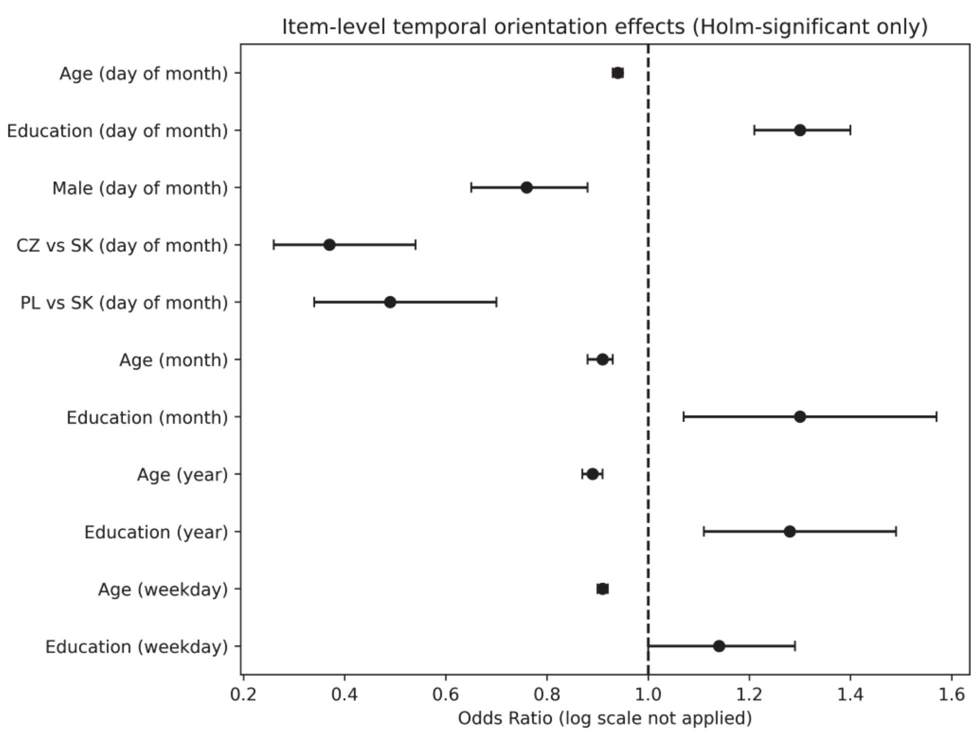
Table 7. Item-level logistic regression results for temporal orientation (V4, SHARE W9)

Predictor OR; [95% CI]; *p*; *p*(Holm)	A) Day of month (cf003)	B) Month (cf004)	C) Year (cf005)	D) Day of week (cf006)
Age (per year)	0.94; [0.93–0.95]; $p < 0.001$; **$p < 0.004$**	0.91; [0.88–0.93]; $p < 0.001$; **$p < 0.004$**	0.89; [0.87–0.91]; $p < 0.001$; **$p < 0.004$**	0.91; [0.90–0.92]; $p < 0.001$; **$p < 0.004$**
Education (ISCED, level)	1.30; [1.21–1.40]; $p < 0.001$; **$p < 0.004$**	1.30; [1.07–1.57]; $p = 0.014$; **$p = 0.014$**	1.28; [1.11–1.49]; $p < 0.001$; **$p = 0.004$**	1.14; [1.00–1.29]; $p = 0.046$; **$p = 0.046$**
Male (vs female)	0.76; [0.65–0.88]; $p < 0.001$; **$p < 0.004$**	0.99; [0.65–1.49]; $p = 0.942$; $p = 0.942$	0.88; [0.63–1.23]; $p = 0.461$; $p = 0.922$	0.73; [0.55–0.96]; $p = 0.069$; $p = 0.069$
Czech Republic (28 vs SK)	0.37; [0.26–0.54]; $p < 0.001$; **$p < 0.004$**	1.40; [0.68–2.87]; $p = 0.356$; $p = 0.712$	0.43; [0.15–1.21]; $p = 0.327$; $p = 0.327$	1.28; [0.75–2.18]; $p = 0.712$; $p = 0.712$
Poland (29 vs SK)	0.49; [0.34–0.70]; $p < 0.001$; **$p < 0.004$**	1.36; [0.67–2.73]; $p = 0.396$; $p = 0.792$	0.31; [0.11–0.87]; $p = 0.075$; $p = 0.075$	1.04; [0.62–1.74]; $p = 0.877$; $p = 0.877$
Hungary (32 vs SK)	0.99; [0.65–1.53]; $p = 0.980$; $p = 1.000$	3.00; [1.13–7.99]; $p = 0.108$; $p = 0.108$	0.30; [0.10–0.88]; $p = 0.108$; $p = 0.108$	1.06; [0.59–1.90]; $p = 1.000$; $p = 1.000$

Notes: Outcome: correct response (=1) for each orientation item. Models: binary logistic regression, adjusted for age, education (ISCED trend), gender, and country. Reference categories: female; Slovakia (country=63). Multiple testing: Holm correction applied across the four items for each predictor. Bold: effects remaining significant after Holm correction.

$p < 0.004$). Gender effects were limited and largely attenuated after correction; for the day of the week item, the initially observed association did not remain significant after Holm adjustment (p_Holm = 0.069). Overall, item-level analyses indicate that differences observed in aggregate orientation outcomes are primarily driven by components requiring finer temporal discrimination, while age and education gradients were consistently present across all items, in line with the ORIENT and ORIENT_BIN models (Chart 1).

Model discrimination assessed by ROC analysis yielded an AUC of 0.696 [SE = 0.009, 95% CI (0.678–0.714), $p < 0.001$], indicating acceptable discrimination between respondents with perfect orientation and those with any orientation error. Given the intentionally parsimonious sociodemographic predictor set, this level of discrimination is adequate for population-level comparisons and for detecting systematic age-, education-, and country-related gradients in temporal orientation.



Notes: Forest plot of odds ratios (OR) and 95% confidence intervals from item-level logistic regression models for temporal orientation components (day of month, month, year, day of week). Outcomes were coded as correct (=1) vs incorrect (=0). All models were adjusted for age, education (ISCED, linear trend), gender, and country; reference categories were female and Slovakia. Only effects remaining statistically significant after Holm correction for multiple testing across the four items are displayed. The vertical dashed line indicates OR = 1 (no association).

Chart 1. Item-level temporal orientation effects after Holm correction (SHARE Wave 9, V4 countries)

Discussion

This study examined temporal orientation as a rapidly measurable and low-burden cognitive indicator using SHARE Wave 9 data from adults aged 50 years and older in the Visegrád Four countries. Despite a pronounced ceiling effect, temporal orientation proved suitable for identifying social gradients and cross-country differences at the population level, with consistent associations observed in both ordinal and binary analyses. These results corroborate prior research suggesting that elementary orientation assessments retain their discriminative utility even within high-functioning cohorts (Folstein et al., 1975; Guerrero-Berroa et al., 2009; Tsoi et al., 2015).

Among the examined variables, age was identified as the most influential and persistent determinant; a linear decline in the likelihood of achieving a perfect score was observed as age advanced. This trajectory aligns with established neuropsychological frameworks regarding the cognitive senescence process (Harada et al., 2013; Salthouse, 2019). Furthermore, superior educational attainment exerted a consistent buffering effect across all orientation metrics. This finding reinforces the cognitive reserve hypothesis, illustrating that educational disparities remain discernible even through the lens of fundamental cognitive markers (Stern, 2002, 2012). While gender-based variations were less pronounced, the observed trend of slightly lower performance among male participants suggests that sex is a secondary, though not negligible, factor in comparison to age and education (Mielke et al., 2014).

International comparisons revealed that respondents in the Czech Republic and Poland exhibited less optimal orientation profiles relative to their Slovak counterparts, whereas no substantial divergence was noted for the Hungarian sample. These disparities should be framed as broad population-level gradients rather than clinical diagnostic deviations. Such variations potentially stem from diverse systemic factors, including public health infrastructure, preventive strategies, and the organisation of long-term care. By concentrating on the V4 region, this analysis provides a unique vantage point to examine these trends within a shared socio-historical and institutional landscape (Livingston et al., 2020; Prince et al., 2015).

Item-level analyses complemented the aggregate indicators by showing that social and country differences were primarily concentrated in the day of the month item, which requires finer temporal discrimination, while simpler orientation components approached ceiling performance. This pattern is consistent with evidence that individual items within brief cognitive tests differ in sensitivity, and that more demanding orientation tasks contribute more strongly to the detection of group differences (Crane et al., 2006; Teresi and Fleishman, 2007).

From a clinical and care management perspective, temporal orientation should therefore be interpreted as a low-threshold risk indicator rather than a diagnostic measure. In this role, it may support the identification of cognitively vulnerable groups, guide further assessment, and serve as a population-level benchmark in nursing and social care contexts (Bae et al., 2021; WHO, 2023). Methodologically, the combined use of binary outcomes, a parsimonious predictor set, and item-level analyses allowed stable and reproducible identification of population patterns, with the observed discrimination performance (AUC ≈ 0.70) consistent with expectations for population-level models aimed at detecting structural gradients rather than individual prediction (Steyerberg et al., 2010).

Strengths and limitations

A major strength of this study is the use of the large, internationally harmonised SHARE database, which enables comparable population-level analyses of temporal orientation across the Visegrád Four countries. Standardised data collection and uniform processing procedures support both internal and external validity and facilitate cross-country comparability (Bergmann et al., 2019; Börsch-Supan et al., 2013). Furthermore, the methodological rigour is enhanced by integrating a parsimonious modeling approach with granular, item-level examinations. This dual strategy effectively mitigates the risk of overfitting while facilitating the robust identification of socio-demographic and cross-national disparities. Such an analytical framework is particularly advantageous for evaluating elementary cognitive markers that exhibit significant ceiling effects, ensuring that subtle gradients remain detectable despite the skewed distribution of raw data (Crane et al., 2006; Teresi and Fleishman, 2007).

The main limitations include the cross-sectional design, which precludes causal inference and the assessment of individual cognitive trajectories, and the use of temporal orientation as a simple indicator that cannot capture the full spectrum of cognitive functioning. Given the strong ceiling effect, temporal orientation is primarily suited to identifying population-level vulnerability patterns and should not be interpreted as a substitute for comprehensive neuropsychological assessment (Salthouse, 2019; Tsoi et al., 2015).

Implications and future research directions

The findings indicate that temporal orientation can serve as a low-resource indicator for population-level risk mapping in aged and community care settings. Although not a diagnostic measure, it may support the targeted prioritisation of further cognitive and functional screening, particularly in resource-constrained care systems (Prince et al., 2015; WHO, 2023). In nursing and social care contexts, benchmarking temporal orientation may facilitate cross-country and regional comparisons and support monitoring of vulnerable populations, in line with international recommendations emphasising early detection of dementia and age-related cognitive decline as a public health priority (Bae et al., 2021; Livingston et al., 2020).

Future research should focus on longitudinal analyses of temporal orientation to examine how changes over time predict cognitive decline, functional deterioration, and increasing care needs. The longitudinal architecture of the SHARE database offers a distinctive vantage point for examining idiosyncratic cognitive trajectories, longitudinal national trends, and the complex interplay between orientation and a wider array of health, psychosocial, and neurocognitive markers (Börsch-Supan et al., 2013; Steyerberg et al., 2010).

Conclusion

This investigation demonstrates that temporal orientation – notwithstanding its parsimonious nature – yields substantial insights into the structural distribution of cognitive vulnerability at the population level. Our findings within the V4 region (SHARE Wave 9) confirm the robustness of this metric for cross-national comparisons, the formulation of research hypotheses, and as a supportive tool for health service planning. Subsequent longitudinal and systemic evaluations should aim to further elucidate the utility of temporal orientation in the early identification of cognitive decline and the development of tailored clinical interventions.

Ethical considerations

The SHARE project adheres to rigorous ethical and data privacy standards across all participating jurisdictions. As the current analysis relied exclusively on anonymised, secondary datasets, no additional ethical clearance was mandated.

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Conflict of interest

The authors have no conflict of interest to declare with respect to the research, authorship, and/or publication of this work.

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