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The Invisible Cost: Contemporary Economic Valuation of Unpaid Care in Epidermolysis Bullosa Across Six European Countries

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Abstract

Background

Epidermolysis bullosa (EB) requires lifelong and technically complex care, much of which is provided at home by unpaid family caregivers. Although informal caregiving represents an important component of the socioeconomic burden of EB, contemporary multinational estimates based on individual caregiving activities remain limited. This study quantified the time devoted to unpaid caregiving in EB and estimated its economic value across six European countries.

Methods

This analysis was conducted within BUR-EB, a multicentre cross-sectional study performed between 2022 and 2025 in Austria, Bulgaria, France, Germany, Hungary, Italy and Spain. Primary caregivers reported weekly time devoted to 12 caregiving activities. Caregiving analyses were restricted to six countries because Hungary was excluded from these analyses. Implausible totals exceeding 168 h/week were excluded. Informal care was valued using the replacement-cost method, with national registered nurse rates as the principal scenario and home-care aide rates as a conservative scenario. To facilitate cross-country comparisons, annual replacement costs were additionally expressed relative to national minimum wage (NMW).

Results

After exclusions, 58 caregivers of children and 46 caregivers of adults were analysed. Median caregiving time was 34.7 h/week (IQR 15.1–74.0; mean 45.5) for caregivers of children and 24.2 h/week (IQR 11.0–40.0; mean 29.2) for caregivers of adults, corresponding to approximately 1,805 and 1,261 h/year, respectively.

Among caregivers of children, median weekly care time was 36.0 h for dystrophic EB (DEB), 36.2 h for junctional EB (JEB), and 15.1 h for EB simplex (EBS). Corresponding values among caregivers of adults were 26.2, 15.0, and 9.3 h/week.

Wound dressing, therapeutic bathing, and medication administration collectively accounted for approximately 40% of caregiving time. At registered nurse replacement rates, annual values ranged from €14,439 to €63,169 for caregivers of children and from €10,088 to €44,135 for caregivers of adults. When expressed relative to NMW, the corresponding ranges were 1.9–3.0 and 1.3–2.1 times annual NMW.

Conclusions

Unpaid caregiving represents a substantial component of EB disease management, particularly for children and people with DEB. Although nominal replacement costs differ considerably between countries, expressing them relative to national wage levels provides a complementary measure of the

economic contribution made by families. These findings provide contemporary evidence that may inform future socioeconomic evaluations, health technology assessments, and consideration of caregiver support within EB care pathways.

BACKGROUND

Epidermolysis bullosa (EB) comprises a heterogeneous group of rare inherited skin fragility disorders. Four major types are recognised: EB simplex (EBS), junctional EB (JEB), dystrophic EB (DEB), and Kindler EB [1]. Estimated prevalence varies according to EB type and country [2]. French national data have additionally characterised the epidemiology of EB and its expert healthcare network [3].

EB is associated with substantial impairment in health-related quality of life resulting from chronic pain, pruritus, functional limitations, and social consequences [4]. Its burden extends to families, who experience substantial psychological, practical, and socioeconomic consequences related to caregiving [5–8].

Daily management frequently requires blister care, therapeutic bathing, dressing changes, infection prevention, medication administration, and pain management [9–11]. Many of these activities are performed at home by family caregivers. Wound care can be particularly demanding, and caregiver-reported practices may vary substantially [12]. Clinical practice guidance also illustrates that several components of EB management require competencies comparable to those provided by trained healthcare professionals [13].

The resulting family burden can be considerable. Previous studies have documented effects on employment, daily activities, psychological well-being, and household expenditure [6, 14]. Informal care therefore represents an important but incompletely visible component of the economic burden of EB.

Earlier European studies established that informal caregiving contributes substantially to EB-related socioeconomic costs [15, 16]. More recent work has quantified community-care costs in recessive DEB [17]. However, contemporary multinational evidence based on a bottom-up measurement of individual caregiving activities remains limited.

Economic valuation of informal care can be undertaken using the replacement-cost, or proxy-good, approach, in which unpaid caregiver time is valued according to the cost of purchasing equivalent formal care [18]. Such valuation is particularly relevant in EB because families routinely undertake time-intensive activities that would otherwise require professional or paid assistance.

The present analysis of the BUR-EB study therefore aimed to quantify weekly unpaid caregiving time among caregivers of children and adults with EB, characterise its distribution by EB type and caregiving activity, estimate its annual economic value using the replacement-cost method, and compare the relative economic burden across European countries by expressing replacement costs in relation to national minimum wage.

METHODS

Study design and population

BUR-EB is a multicentre cross-sectional study conducted between 2022 and 2025 in Austria, Bulgaria, France, Germany, Hungary, Italy, and Spain in collaboration with EB reference centres and national DEBRA associations.

Patients with a confirmed diagnosis of EB residing in a participating country were eligible for the study. The caregiver component required separate consent. The present analysis was restricted to primary caregivers who provided the required consent and completed the caregiving questionnaire.

Non-response to the caregiver questionnaire was treated as missing and was not interpreted as absence of caregiving. Consequently, the estimates reported here describe caregiving among responding caregivers and should not be interpreted as population-level average caregiving costs per person with EB.

Although the broader BUR-EB study involved seven countries, Hungary was excluded from the caregiving analyses. Two adult-caregiver respondents residing outside the seven participating countries, in Tunisia and Egypt, were also excluded from the present analysis.

Caregiver characteristics

Among caregivers of children, 99% were parents, 91% were women, and 87% were aged 31–50 years. Among caregivers of adults, 70% were parents and 19% were partners; 68% were women and 61% were older than 50 years.

Measurement of caregiving time

Weekly caregiving time was collected using online or paper questionnaires administered in the relevant local language.

Twelve caregiving activities were assessed: wound dressing changes (SQ001), therapeutic bath (SQ002), basic hygiene/dressing (SQ003), showering/bathing (SQ004), meal preparation (SQ005), feeding assistance (SQ006), medication administration (SQ007), medical appointments (SQ008), organisational tasks (SQ009), supervision/monitoring (SQ010), patient-association participation (SQ011), and other activities (SQ012).

For each activity, caregivers reported the average time spent per week in hours and minutes. Total weekly caregiving time was calculated as the sum of the 12 reported activities.

Management of implausible values

Because a week contains a maximum of 168 hours, total reported caregiving time exceeding 168 h/week was considered implausible and excluded.

Seven caregivers of children were excluded on this basis: two in Austria, three in Germany, one in Bulgaria, and one in Spain. Three caregivers of adults were excluded: two in Austria and one in Spain. The Spanish adult-caregiver observation corresponded to 1,534 h/week and was considered a manifest data-entry error.

After these exclusions and the exclusion of Hungary, the final analytic samples comprised 58 caregivers of children and 46 caregivers of adults.

Economic valuation of informal care

Informal caregiving was valued using the replacement-cost method, also referred to as the proxy-good method [18]. This approach estimates the monetary value of unpaid care according to the cost of employing a professional to provide equivalent services.

Annual replacement cost was calculated as:

Annual replacement cost (€) = median weekly caregiving hours × 52 × national professional hourly rate (€)

Two scenarios were considered: a home-care aide rate as the conservative scenario and a registered nurse home-care rate as the principal scenario.

The registered nurse scenario was selected as the principal analysis because a substantial proportion of the activities reported by caregivers involved wound management, therapeutic bathing, and medication administration. The replacement-cost approach values the type of service being provided rather than the caregiver's own salary or foregone earnings.

National professional rates and NMW values were obtained from the sources specified in Supplementary Table S2 using January 2026 values. For Austria and Italy, where no statutory national minimum wage exists, sector-specific collective-agreement minima were used.

For cross-country comparison, annual replacement cost was divided by annual NMW:

NMW ratio = annual replacement cost / annual NMW

The resulting ratio represents the replacement value of one year of unpaid caregiving expressed in units of annual minimum-wage income.

Statistical analysis

Given the right-skewed distribution of caregiving time, the median was used as the principal measure for economic valuation. Means, standard deviations, quartiles, and maxima are additionally reported to describe the distribution.

Analyses were performed using Python 3.12.

RESULTS

Study population and caregiver participation

Caregiver participation varied across countries. Sixty-six caregivers of children completed at least one of the 12 caregiving activity items, of whom 58 were retained for analysis.

Fifty-four caregivers of adults responded to the caregiving component; after geographical and data-quality exclusions, 46 were included in the analysis.

The country-specific flow from the broader BUR-EB population to the final caregiver samples is presented in Table 1.

Table 1
BUR-EB study population and caregiver participation by country.

Adults, quality-of-life database	France	Germany	Austria	Italy	Spain	Bulgaria	Hungary
	71	33	28	26	18	16	9
Children, quality-of-life database	**34**	**23**	**19**	**20**	**15**	**15**	**13**
Caregivers of children — respondents (n = 66)	**9**	**14**	**9**	**14**	**7**	**12**	**1**
Caregivers of children — analysed (n = 58)	**9**	**11**	**7**	**14**	**6**	**11**	**—**
Caregivers of adults — respondents (n = 54)*	**5**	**7**	**10**	**14**	**7**	**6**	**3**
Caregivers of adults — analysed (n = 46)	**5**	**7**	**8**	**14**	**6**	**6**	**—**

*Respondents are caregivers who completed at least one of the 12 activity items. * Two adult-caregiver respondents resident outside the seven study countries (Tunisia, Egypt) are included in the respondent total (n = 54) but are not shown by country and were excluded from analysis. Implausible values excluded (> 168 h/week): 7 caregivers of children (Austria ×2, Germany ×3, Bulgaria ×1, Spain ×1); 3 caregivers of adults (Austria ×2, Spain ×1 [1,534 h/week, manifest data-entry error]). Hungary was excluded from all caregiving analyses (1 caregiver of children, 3 caregivers of adults). France, caregivers of adults (n = 5): small sample, interpret with caution.*

Weekly caregiving time

Among caregivers of children, median total caregiving time was **34.7 h/week (IQR 15.1–74.0)**, compared with a mean of 45.5 h/week (SD 40.6). The maximum retained value was 162.8 h/week. Median caregiving time corresponded to approximately 1,805 h/year.

Among caregivers of adults, median caregiving time was **24.2 h/week (IQR 11.0–40.0)**, compared with a mean of 29.2 h/week (SD 23.7). The maximum retained value was 89.7 h/week, corresponding to approximately 1,261 h/year at the median.

The difference between means and medians illustrates the right-skewed nature of the distributions and supports the use of medians as the principal valuation measure (Table 2,Fig. 1).

Table 2
Distribution of weekly caregiving time after exclusion of values above 168 h/week.

Statistic	Caregivers of children (n = 58)	Caregivers of adults (n = 46)
Median (principal indicator)	**34.7 h/week**	**24.2 h/week**
Mean	**45.5 h/week**	**29.2 h/week**
SD	**40.6 h/week**	**23.7 h/week**
P25	**15.1 h/week**	**11.0 h/week**
P75	**74.0 h/week**	**40.0 h/week**
Maximum after exclusion	**162.8 h/week**	**89.7 h/week**
Annual hours (median × 52)	**1,805 h/year**	**1,261 h/year**
IQR, interquartile range; SD, standard deviation.		

Caregiving time according to EB type

Among caregivers of children, median weekly caregiving time was 36.0 h for DEB (n = 36), 36.2 h for JEB (n = 6), and 15.1 h for EBS (n = 13).

Among caregivers of adults, median weekly caregiving time was 26.2 h for DEB (n = 26), 15.0 h for JEB (n = 9), and 9.3 h for EBS (n = 10).

These descriptive results indicate substantial variation according to EB type, with greater caregiving time observed among caregivers of people with DEB than among those caring for people with EBS. Given the small numbers in some subtype groups, particularly JEB, these comparisons should be interpreted cautiously.

Distribution of caregiving activities

Caregiving comprised both general assistance and technically demanding activities. Wound dressing (SQ001), therapeutic bathing (SQ002), and medication administration (SQ007), considered nurse-level activities in the valuation framework, collectively represented approximately 40% of reported caregiving time.

Some activities, particularly supervision, may occur concurrently with other caregiving activities. The summed activity totals should therefore be interpreted as reported activity-specific time rather than necessarily mutually exclusive clock time.

Economic valuation: caregivers of children

Using the pooled median of 34.7 h/week, equivalent to approximately 1,805 h/year, annual replacement costs at national registered nurse rates ranged from **€14,439 in Bulgaria to €63,169 in Germany**.

The corresponding estimate for France was **€50,535/year**, with additional estimates of €54,145 for Austria, €36,097 for Italy, €27,072 for Spain, and €14,439 for Bulgaria (Table 3).

Table 3
Economic valuation of unpaid EB care by country at the registered nurse replacement cost.

Country	NMW / month	Nurse €/h	Children, 34.7 h/week (1,805 h/year), €/year	× NMW	Adults, 24.2 h/week (1,261 h/year), €/year	× NMW
France	€1,802	€28	€50,535	2.3×	€35,308	1.6×
Germany	€2,221	€35	€63,169	2.4×	€44,135	1.7×
Austria	~€1,700	€30	€54,145	2.7×	€37,830	1.9×
Italy	~€1,000	€20	€36,097	3.0×	€25,220	2.1×
Spain	€1,184	€15	€27,072	1.9×	€18,915	1.3×
Bulgaria	€620	€8	€14,439	1.9×	€10,088	1.4×

NMW, national minimum wage. Values are the median weekly hours of the total sample × 52 × the national nurse hourly rate. Hungary was excluded from all caregiving analyses. Austria and Italy have no statutory NMW; sector-specific collective agreement minima were used. Home care aide estimates are given in Supplementary Table S2.

When expressed relative to annual NMW, the estimates ranged from **1.9× NMW in Spain and Bulgaria to 3.0× in Italy**.

Economic valuation: caregivers of adults

Using the pooled median of 24.2 h/week, equivalent to approximately 1,261 h/year, annual registered nurse replacement costs ranged from **€10,088 in Bulgaria to €44,135 in Germany**.

The corresponding French estimate was **€35,308/year**, with €37,830 for Austria, €25,220 for Italy, and €18,915 for Spain (Table 3).

NMW-normalised values ranged from **1.3× annual NMW in Spain to 2.1× in Italy**.

Cross-country comparison

Nominal wage levels varied considerably across the participating countries, with the NMW measure used in the analysis ranging from €620/month in Bulgaria to €2,221/month in Germany.

Despite these differences, the NMW-normalised replacement-cost estimates occupied a narrower range: **1.9–3.0 times annual NMW for caregivers of children and 1.3–2.1 times annual NMW for caregivers of adults** (Fig. 2).

These ratios should be interpreted as descriptive cross-country economic indicators rather than as evidence that caregiver burden is identical across national healthcare systems.

DISCUSSION

This multinational analysis demonstrates that unpaid caregiving constitutes a substantial component of EB management. Responding primary caregivers of children reported a median of 34.7 h of care each week, while caregivers of adults reported 24.2 h/week. The persistence of substantial caregiving time among adults indicates that family care requirements can continue well beyond childhood.

The results extend earlier evidence on the socioeconomic burden of EB [15–17] by using a bottom-up, activity-based approach. Rather than valuing informal care solely as one component of an aggregate cost-of-illness estimate, the BUR-EB questionnaire recorded time devoted to 12 individual caregiving activities. This approach provides additional information about the nature of the work performed by family caregivers.

The observed distribution by EB type is also clinically relevant. DEB was associated with substantially greater median caregiving time than EBS in both children and adults. However, these are descriptive subgroup findings, and the small sample sizes, particularly for JEB, preclude strong comparative conclusions.

A major component of caregiving involved wound dressing, therapeutic bathing, and medication administration. These activities collectively accounted for approximately 40% of reported time and include tasks that overlap with competencies normally associated with professional healthcare provision [9, 13]. This finding supports the use of professional replacement rates as one way of estimating the economic value of unpaid care.

The replacement-cost estimates should nevertheless be interpreted carefully. They do not represent money actually paid to caregivers, household income lost by caregivers, or the budgetary cost of introducing professional home-care services. Rather, they estimate the value of caregiver time according to the cost of purchasing an equivalent service. This distinction is fundamental when interpreting the figures and comparing them with opportunity-cost or cost-of-illness estimates [18].

Absolute replacement costs differed markedly between countries because professional wage levels vary across Europe. Expressing these values relative to NMW reduced this nominal cross-country dispersion. The NMW-normalised estimates ranged from 1.9 to 3.0 annual minimum wages for caregivers of children and from 1.3 to 2.1 for caregivers of adults.

These results suggest that substantial unpaid economic value is generated by caregivers across countries with very different wage levels, although the ratios should not be interpreted as demonstrating identical socioeconomic circumstances or healthcare support across countries.

The present estimates may also provide a framework for considering the economic implications of interventions that reduce caregiving time. For example, a previously reported reduction in dressing-change time of 10.7 h/week associated with Oleogel-S10 [19], if applied illustratively to the French

registered-nurse rate of €28/h used in this analysis, would correspond to approximately €15,579/year in replacement-cost value.

This is a secondary illustrative calculation based on published dressing-time data and the valuation assumptions of the present study, rather than an economic outcome measured in that clinical trial.

Caregiving burden extends beyond economic value. Qualitative and observational research has documented psychological, emotional, and social consequences for families caring for people with EB [20–22].

Within the same BUR-EB programme, a recent multinational analysis reported substantial impairment of health-related quality of life among adults with EB [23]. The economic estimates presented here should therefore be viewed as one component of a broader patient and family burden.

From a health-policy perspective, the findings provide quantitative information relevant to discussions about caregiver recognition, access to professional home nursing, and respite support. However, the present cross-sectional study did not evaluate the effectiveness or cost-effectiveness of such interventions. These options therefore require dedicated evaluation before specific reimbursement or service-delivery recommendations can be made.

Strengths and limitations

A principal strength of the study is its multicountry design and activity-based measurement of caregiving time. The use of the same caregiving framework across participating countries enables comparison within a common analytical approach. Reporting both nominal replacement costs and NMW-normalised values also distinguishes absolute monetary value from relative national wage context.

Several limitations must be considered.

First, caregiving time was self-reported and is therefore subject to reporting and recall error.

Second, time devoted to the 12 activities was summed, although some activities may occur simultaneously. This may overestimate clock time among caregivers reporting intensive supervision or overlapping activities.

Third, values exceeding 168 h/week were excluded as implausible. Although this provides a transparent physical upper bound, other inaccurate observations below this threshold may remain.

Fourth, only the primary caregiver is represented in the principal analysis. Contributions made by secondary caregivers are therefore not included, potentially underestimating total family caregiving.

Fifth, recruitment through specialist reference centres and patient organisations may favour families with more severe or care-intensive disease. DEB represented approximately 62% of analysed caregivers

of children and 57% of caregivers of adults. The pooled estimates should consequently not be extrapolated without adjustment to EB populations with a different case mix.

Sixth, participation varied considerably between countries, and several national samples were small. In particular, the adult-caregiver sample in France comprised only five participants. Country-specific results should therefore be interpreted cautiously.

Seventh, the replacement-cost approach values the professional service required to substitute for informal care and does not measure the caregiver's own opportunity cost, lost earnings, or willingness to pay.

Eighth, the proportions attributed to different caregiving activities were estimated from the observed activity distributions rather than directly calculated as individual-level proportions for every participant.

Finally, the analysis includes only consenting caregivers who responded to the caregiver questionnaire. The estimates therefore represent burden **per responding caregiver**, not average caregiving cost per EB patient in the participating countries. This distinction is particularly important when comparing these estimates with population-level or top-down cost-of-illness studies.

CONCLUSIONS

Unpaid family caregiving represents a substantial and economically important component of EB management. In this multinational BUR-EB analysis, primary caregivers reported median care requirements of 34.7 h/week for children and 24.2 h/week for adults, with greater time requirements observed in DEB than EBS.

Replacement-cost valuation demonstrates that the economic value of this unpaid work is substantial across all six countries studied. Normalisation by national wage levels provides an additional perspective for comparing countries with markedly different nominal wages.

These findings provide contemporary quantitative evidence that can inform future economic evaluations, health technology assessments, and research into caregiver-support strategies. They also support the inclusion of informal caregiving as an explicit component when assessing the broader societal burden of EB.

Abbreviations

DEB
Dystrophic epidermolysis bullosa
EB
Epidermolysis bullosa
EBS
Epidermolysis bullosa simplex

FTE
Full-time equivalent
IQR
Interquartile range
JEB
Junctional epidermolysis bullosa
NMW
National minimum wage
SD
Standard deviation

Declarations

Ethics approval and consent to participate

Informed consent was obtained from all individual participants included in the study. Approval for the study was granted by ethics committee in each participating country: Ethics Commission of the Faculty of Psychotherapy Science and the Faculty of Psychology, Sigmund Freud University, Austria; Ethics Committee at the St. Panteleimon Hospital, Plovdiv, Bulgaria; Assitance Hôpitaux Publique de Paris, Bureau de la Protection des Données, France; Ethics Committee of Albert-Ludwigs-University Freiburg (22-1519-S2), Germany; Hungarian Medical Research Council (BM/26385-3/2023), Hungary; Ospedale Pediatrico Bambino Gesù Ethics Committee, Italy (protocol n. 3107/2023); Complejo Hospitalario Universitario de Canarias Ethics Committee, Spain.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interest for this manuscript.

Role of the Funder/Sponsor

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Use of artificial intelligence

Artificial intelligence (AI) tools were used solely to improve the visual presentation and readability of the figures. All scientific analyses, interpretation of the results, and manuscript preparation remain the sole responsibility of the authors, who reviewed and approved the final content.

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Author Contribution

Conceptualization: CB, RJ, VAF, MEH, CH, AH, VH, GI, MM, GS, IY, MP, CC, RL. Data curation: CT. Formal analysis: CT, CB, CC. Funding acquisition: CB, RL. Investigation: CB, RJ, VAF, MEH, CH, AH, VH, GI, MM, GS, IY, MP, CT, CC, RL. Methodology: CB, RJ, VAF, MEH, CH, AH, VH, GI, MM, GS, IY, MP, CC, RL. Project administration: CB, CC. Resources: CB, RJ, VAF, MEH, CH, AH, VH, GI, MM, GS, IY, MP, CT, CC, RL. Supervision: CB. Validation: CT, CB, CC. Visualization: CT. Writing—original draft preparation: CT, CB, CC. Writing—review and editing: CB, RJ, VAF, MEH, CH, AH, VH, GI, MM, GS, IY, MP, CT, CC, RL. All authors read and approved the final manuscript.

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Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures

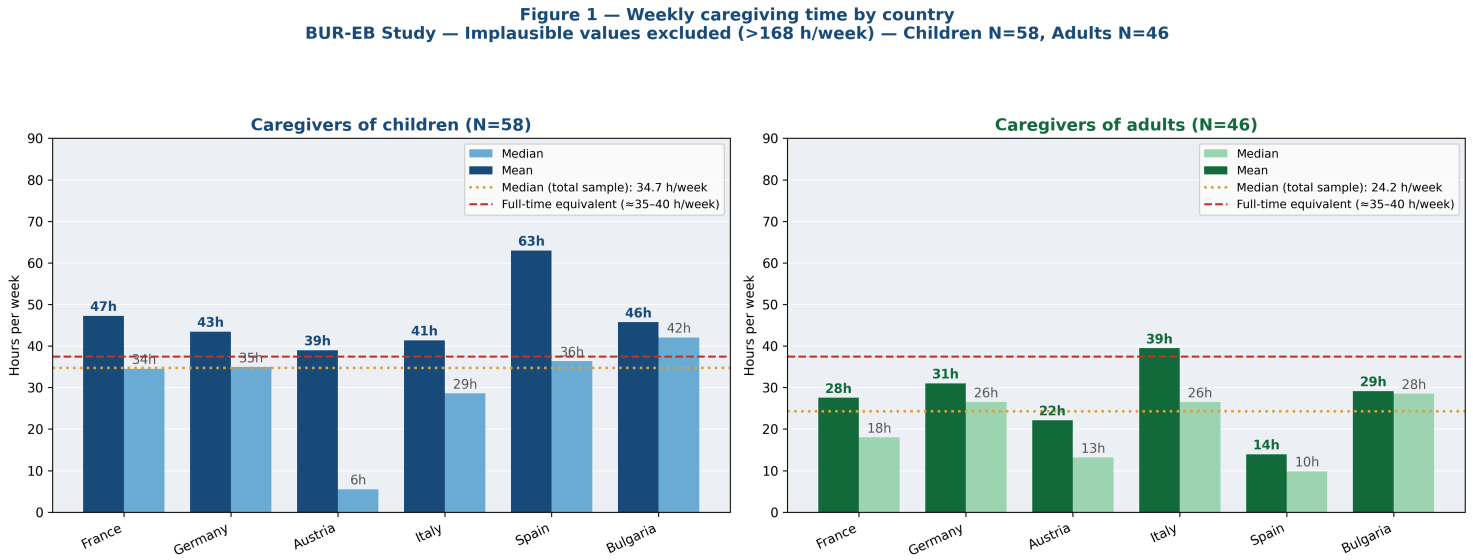

Figure 1

Weekly caregiving time by country.
Mean and median weekly caregiving time in each country after exclusion of implausible values above 168 h/week (caregivers of children, n=58; caregivers of adults, n=46). Gold dotted line indicates the median of the total sample (34.7 h/week for caregivers of children and 24.2 h/week for caregivers of adults). Red dashed line indicates an approximate full-time equivalent (35–40 h/week according to national standards).

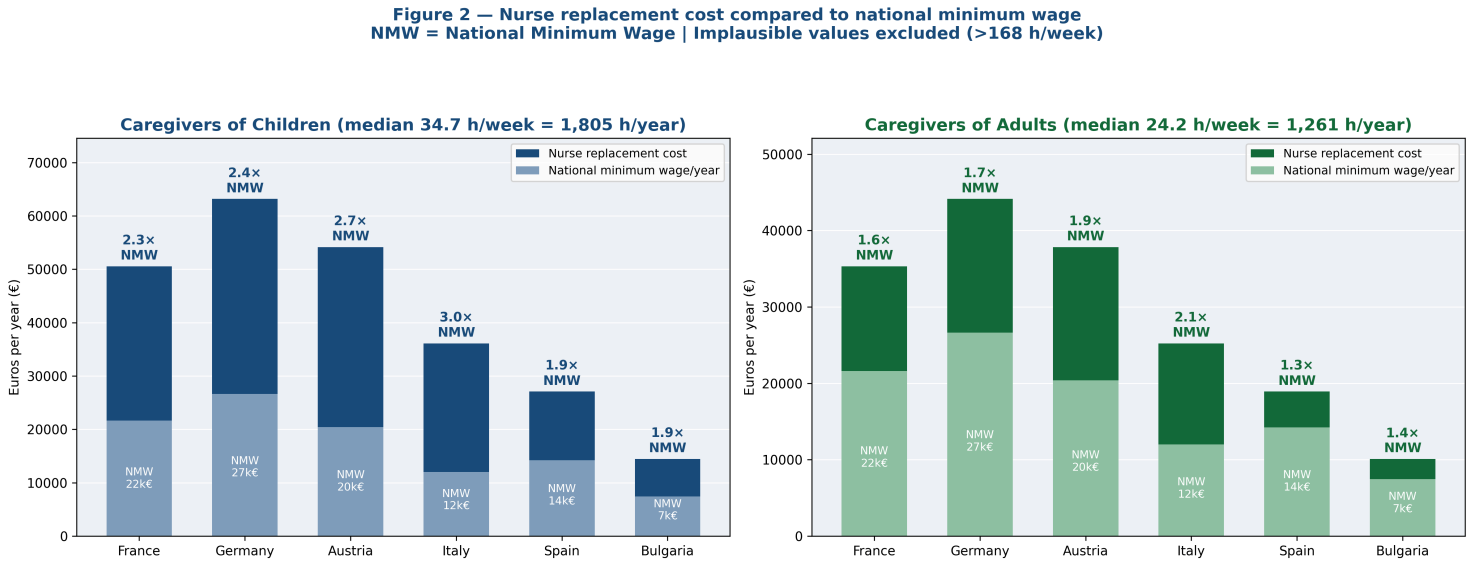

Figure 2

Registered nurse replacement cost compared with national minimum wage.

Supplementary Files

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