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## **Does the formal home care provided to old-adults persons affect utilisation of support services by informal carers? An analysis of the French CARE and the U.S. NHATS/NSOC surveys**

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### **Abstract:**

The role of informal carers in long-term care sheds light on the struggle related to population ageing and the increasing incidence of chronic disease. However, despite the increasing number of informal carers, most of them experienced the burden of caregiving. Since various policies have been implemented across countries to support informal carers, their attitude toward support services should be addressed. This research consisted of investigating how formal home care affected the utilisation of support services by informal carers. Data used stemmed from the 2015 Survey Capacité Aide et Ressources des Seniors ("CARE ménage") collected in France; and the National Health and Aging Trends Survey (NHATS) with the National Survey of Caregiving (NSOC) in the United States of America (U.S.). Andersen's health behavioural model of support services utilisation provided a conceptual framework for investigating predisposing, enabling, and need variables associated with informal carers services use. We used a probit model for econometrics modelling. We also checked for the endogeneity of formal care. A sample of N = 4,866 in France and N = 1,060 in the U.S. informal carers and care recipients' dyads were used in the study. In France, the care recipients' formal care utilisation does not influence the carer support service use. Comparatively, in the United States, formal care significantly increases the respite services utilisation by informal carers. This study provides important implications for Long-Term Care (TLC) dedicated to health policy, for an optimal trade-off between informal and formal care use, bearing in mind health system specificities. First, countries may spend more funds in innovative support programs in access to care, because some carers may have difficulties in accessing and using support services. Secondly, to provide and foster information campaigns to raise awareness concerning the utilisation of various existing health services, to improve social welfare..

### **Keywords:**

Surveys, lab experiments, distributive preferences, prioritarianism, inequality aversion

### **JEL codes:**

D63, D71

Does the formal home care provided to old-adults persons affect utilisation of support services by informal carers? An analysis of the French *CARE* and the U.S. NHATS/NSOC surveys

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**Abstract**

The role of informal carers in long-term care sheds light on the struggle related to population ageing and the increasing incidence of chronic disease. However, despite the increasing number of informal carers, most of them experienced the burden of caregiving. Since various policies have been implemented across countries to support informal carers, their attitude toward support services should be addressed. This research consisted of investigating how formal home care affected the utilisation of support services by informal carers. Data used stemmed from the 2015 Survey *Capacité Aide et Ressources des Seniors* (“*CARE ménage*”) collected in France; and the National Health and Aging Trends Survey (NHATS) with the National Survey of Caregiving (NSOC) in the United States of America (U.S.). Andersen’s health behavioural model of support services utilisation provided a conceptual framework for investigating predisposing, enabling, and need variables associated with informal carers services use. We used a *probit* model for econometrics modelling. We also checked for the endogeneity of formal care. A sample of N = 4,866 in France and N = 1,060 in the U.S. informal carers and care recipients’ dyads were used in the study. In France, the care recipients’ formal care utilisation does not influence the carer support service use. Comparatively, in the United States, formal care significantly increases the respite services utilisation by informal carers. This study provides important implications for Long-Term Care (TLC) dedicated to health policy, for an optimal trade-off between informal and formal care use, bearing in mind health system specificities. First, countries may spend more funds in innovative support programs in access to care, because some carers may have difficulties in accessing and using support services. Secondly, to provide and foster information campaigns to raise awareness concerning the utilisation of various existing health services, to improve social welfare.

JEL classification: I12; C25; J14; I19; O52

**Keywords:** Formal home care; Informal care; Support service utilisation; Econometrics.

**Abbreviations:** *CARE*: *Capacité Aide et Ressources des Seniors*; *NHATS*: *National Health and Aging Trends Survey*; *NSOC*: *National Survey of Caregiving*; *LTC*: *Long-Term Care*.

## 1. Introduction

For the International Alliance of Carer Organizations (IACO), informal carers are defined as “an unpaid individual, such as a family member, neighbour, close acquaintance or other significant individuals, who takes on a caring role to support someone with reduced physical ability, a debilitating cognitive condition, or chronic life-limiting illness”. In general, informal carers provide care on a deliberated basis, stemming from a prior social relationship, and without monetary incentive or specific training [1]. Based on this definition, informal carers include multiple aspects or dimensions [2–4]. Therefore, informal carers have a ubiquitous and very substantial presence throughout the world. Some estimates show 8.1 million in Canada (2012), 6.5 million in the UK (2011).<sup>1</sup> Furthermore, as a result of this general trend in the incidence of disabilities throughout the world due to the population ageing in European societies, it is widely thought that informal carers play an essential role in the activities of daily living of their loved ones [2,5].

In France, the National Institute for Statistics and Economic Studies (*INSEE*) and the Directorate for Research, Studies, Assessment and Statistics (*DREES* - French Ministry of Health) have shown that the number of informal carers increased from 5 million to 8.3 million people between 1999 and 2008. Based on recent estimates, the number of informal carers is around 11 million people in 2017.<sup>2</sup> The number of disabled/dependent people continues to rise. In 2015, 3 million people aged 60 or older living at home report being regularly assisted in daily life because of their age or health condition [6]. The *INSEE* forecasting projects the number of people over 60 years of age to increase from 12.8 to 20.9 million between 2006 and 2035. Subsequently, estimates realised in the United States (U.S.) population in 2015 showed 43.5 million informal carers, and 47.8 million old-aged 65 and older<sup>3</sup> (almost 15% of the population).<sup>4</sup> Considering the National Population Projection (NPP), the population of people aged 65 and older in 2060 is expected to step up at 98.2 million (i.e. nearly one in four U.S. residents).<sup>5</sup>

Informal care provision is not only provided when the disabled person lives at home or in the community [7] but also when the disabled person is admitted in an institution (long term care facility) [8]. In light of this, it appears that informal carers play a strategic role in the daily activities of their dependent loved ones [9]. Although some carers view care provision as propitious and a generator of positive utility, it is nevertheless true that it can readily be seen to have lost these qualities [10]. When this happens, providing informal care produces negative utility for the carer due to a high risk of exhaustion (burnout), if the carer does not receive any external assistance [11]. Since informal carer experienced burden related to the caregiving tasks, there is no denying that the high risk of death, leading to a reduction of

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<sup>1</sup> <https://internationalcarers.org/carers-facts/global-carer-stats/>

<sup>2</sup> <https://www.fondation-april.org/comprendre/barometre-et-etudes-aidants>

<sup>3</sup> [https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP\\_2015\\_PEPAGESEX&prodType=table](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2015_PEPAGESEX&prodType=table)

<sup>4</sup> <https://www.census.gov/content/dam/Census/newsroom/facts-for-features/2017/cb17-ff08.pdf>

<sup>5</sup> Of these estimates, 19.7 million will be age 85 or older.

time dedicated to care. Despite rapid impairments being observed in certain situations involving an overwhelming burden, there is more concern regarding the gradual worsening of the carer's quality of life [10].

National policies implemented in the majority of EU countries to support long-term carers favoured two main types: financial assistance and in-kind services like the home-based professional services, respite care<sup>6</sup>, counselling, training<sup>7</sup> and support groups<sup>8</sup> [12–15].<sup>9</sup> Such carers' support services were developed to relieve their sense of burden [16–19], improve health and quality of life while continuing caregiving [20–23].

In the majority, the carers' support services are set by the community organisations and/or local association as well as health care services. The strategies dedicated to informal carers vary across countries. The French Ministry of Health is implementing in 2020 "*plan national de renforcement et de diversification des solutions de répit*" (containing six priority and seventeen key points) to support informal carers.<sup>10</sup> It is expected €400M between 2020 - 2022 for the fund and an allocation of €105M to promote and popularise respite services [24].<sup>11</sup> Even though the access to support services may also be limited due to geographical matter [25], the critical question remains how carers target the best support services. In the U.S, under the National Family Caregiver Support Program (NFCSP), a mechanism of funds was allocated proportionally to states' number of residents aged 70 and older. This funding<sup>12</sup> for the NFCSP is devoted to several categories of services: information about support services, assistance accessing support services; counselling; support groups, training, respite and other supplementary services (transportation) [26].

Considering the existing institutional differences between Europe and the United States, our study motivation relies on the framework of informal care and medical care utilization in Europe and the U.S. [27,28]. While the relation between formal care and support services for carers is not intuitive, and this relation has not received much attention in the empirical literature. This study's contribution consisted of analysing how the formal home care use by the elderly affected informal carers support services utilisation. This paper is organised as follow: the next section presents the background necessarily based

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<sup>6</sup> Respite care (short-breaks for carers) means taking a break from caring, while the care recipient look after by someone else. Respite care generally "refers to temporary relief services for families or primary carers of the disabled although the definition may be broadened to reflect distinctions between primary and secondary respite care" [85,86]. See [87] for further details.

<sup>7</sup> Training support is one of the pathways that build on the experience of informal carers can effectively help informal carers to become more aware of their skills, to gain self-confidence and motivation in order to develop their competences even more. Training can help informal carers both to improve their caring experience" [88].

<sup>8</sup> Support groups for carers are one of the few forms of services directly provided for carers. Such groups can be organised in a number of ways, like a day hospital or adult training centre, others are free standing.

<sup>9</sup> For example, In France context, for Gervès et al., (2014) the cash-for-care for the elderly people appear to dominate the one dedicated to carers [90] and the in-kind services deemed underused [91].

<sup>10</sup> <https://www.gouvernement.fr/aidants-une-nouvelle-strategie-de-soutien>

<sup>11</sup> [https://www.gouvernement.fr/sites/default/files/document/document/2019/10/dossier\\_de\\_presse\\_relatif\\_a\\_la\\_strategie\\_de\\_mobilisation\\_et\\_de\\_soutien\\_en\\_faveur\\_des\\_aidants\\_-\\_23.10.2019.pdf](https://www.gouvernement.fr/sites/default/files/document/document/2019/10/dossier_de_presse_relatif_a_la_strategie_de_mobilisation_et_de_soutien_en_faveur_des_aidants_-_23.10.2019.pdf)

<sup>12</sup> An initial dotation was about \$150 million per year, although each state provides additional funds.

on the conceptual framework. Section 3 is devoted to data sources and method. Section 4 summarises the results of the empirical model; Section 5 contains the discussion of the results. The last section is dedicated to the conclusion.

## **2. Background and conceptual framework**

### ***2.1. An empirical relationship between formal, informal care and health services utilisation***

Some research has studied the relationship between formal care<sup>13</sup> and informal care. Informal care and formal care were found substitutes or complements [29–35]. Besides, some studies identified factors influencing carers needs [36,37], the empirical relationship between characteristics and carers support services utilisation has been rarely investigated in the Long-Term care (LTC) issues [38]. Since far studies pay attention to support services use through informal carers characteristics [39]; however, our paper extends this literature by controlling for the endogeneity of formal care, by analysing how formal care affected the four type of support services across France and the U.S.

### ***2.2. Conceptual framework: extension of the Andersen behavioural model to informal carers' health service utilisation***

Most previous studies on health care utilisation pay particular attention to the Andersen (1995) Behavioural Model (BM) [40,41].<sup>14</sup> The Andersen (1995) model was expanded to include both carers and patients characteristics [42]. Theoretically, several factors were associated with health services use behaviour. (i) predisposing factors (age, gender, education, ethnicity, number of children, marital status); (ii) enabling factors (income/financial situation, health insurance), and (iii) need factors (health status, disease/chronic condition). The quasi – majority of studies included such characteristics: the age, the marital status, the gender as predisposing factors, the income and the health insurance as enabling factors and finally the health status as need factors [41]. Although current policies pay particular attention to the increasing demand for LTC, in the literature, some studies addressed the issue related to the support services utilisation by informal carers with the Andresen health behavioural model [43–45]. Figure 1 presented an adapted Andersen health services use model to informal care.

Carers support services use pattern were assessed [43,46]. Hong (2010) found that care recipient and carer- related needs contributed to distinguishing different services use patterns (multiple service users, selective in-home service users, and light service users). Toseland et al. (2002) identified the health and human services utilisation predictors by community-residing persons with dementia and their family carers. He found that predisposing, enabling, and need variables explained 40.9% of the variance in

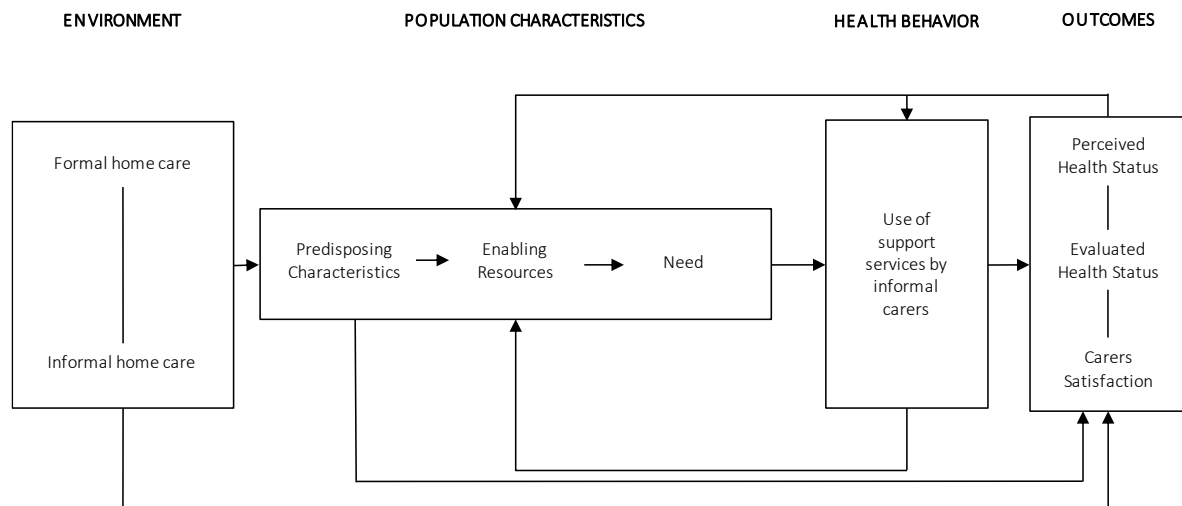
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<sup>13</sup> Formal care for older or elderly people usually refers to paid care services provided by a healthcare institution or individual for a person in need; While Informal care refers to unpaid care provided by family members, close relatives, friends, and neighbourhood. There are three different categories of formal care: (i) home-based care; (ii) community-based care (such as daycare centers with trained staff); and (iii) residential care in the form of nursing homes [92]. In this analysis, we only considered as formal care the category related to home-based care.

<sup>14</sup> The studies using the BM were mostly conducted in the U.S. and the UK (United Kindom).

service use, 29.8% of the variance in health service use, and 38.1% of the variance in the use of human services. Liu et al. (2000) argued that some respite services were rarely accessible to carers. Furthermore, Toseland et al. (2002) concluded that services utilisation are relatively low compared with the high needs of carers.

**Figure 1: Behavioural Model (BM) and expansion to informal care**



Source: Adapted of Andersen (1995)

The analysis of predisposing, enabling and need factors associated with carers' use and nonuse of support services indicated empirical evidence. Carers' use of services can be mainly considered a cultural attitude [49,50]. For Mensie and Steffen (2011), In-home respite utilisation by family carers depends mainly on the caregiving dyad's past in-home respite usage.

Conversely, demographic predisposing factors (relationship, income) and need factors (behavioural dysfunction, functional impairments) are not associated with hours of respite utilisation over three months, nor are the level of depressive carer symptoms [51]. Additionally, being adult children, Black and Hispanic, providing intensive care, living in metropolitan areas, and being residents of states spending more on increasing access to carers services were associated with any unused services [52].

An international comparison across European countries clearly states the health system specificities. For example, in Belgium, some difficulties in accessing support measures include the lack of information expressed by informal carers [9].<sup>15</sup> Whereas, in the U.S., several services barriers<sup>16</sup> discriminated informal carers to support services utilisation, among which awareness and no thought of service were the most prevalent [38].

<sup>15</sup> The lack of timely access to reliable information about formal and informal services in order to proactively support the informal carer; And therefore, they navigated through the health system

<sup>16</sup> According to the authors, services barriers included availability, awareness, affordability, staff quality, privacy violation, complex bureaucracy, language barriers, qualification of each programme and no thought of service.

### 2.3. Hypothesis

Given our conceptual framework, our analysis leads to test some main hypotheses. First, the existence of a relationship (substitutability or complementarity) between informal and formal care. Second, the carers support services use will vary according to recipients formal care utilisation. This second hypothesis is not intuitive. Therefore, we assume that informal and formal home care as a complement in the sense that the marginal benefits of support services to carer health will increase with professional care to the care recipient. Overall, we expect the presence of in-home formal care for older adults, to increase support services use of carers by significantly taking time away from caregiving.

## 3. Data and method

### 3.1. Data sources

Our analysis mainstreamed two nationally representative surveys based on two different datasets. First, we used the data collected in France: survey *Capacités Aides et Ressources des Seniors (CARE ménage)*,<sup>17</sup> including elderly survey [53] and carers survey [54]. This French survey was conducted in 2015 by the *INSEE* and *DREES* with the support of the National Solidarity Fund for Autonomy (CNSA). The main objective was to better understand older adults' living conditions, their relationships with their family and friends, their difficulties in carrying out certain daily life activities, and the financial and human assistance to overcome these difficulties.

The "*CARE ménage – Volet senior*" included older adults aged 60 or over at the start of the survey living permanently in the community. The "*CARE ménage – Volet aidants*" concerns carers (18 years of age or older, living in France metropolitan area) declared by elderly people. The survey protocols favoured face-to-face collection of the data. Nevertheless, the survey was also conducted by phone when carer was not present at home and during the interview of the elderly. Almost 10,628 elderly (elderly persons aged 60 and over) responded to the survey, while 6,201 informal carers (over 18 years of age) of in-home old-adults responded to the informal carer section.

Secondly, we used data from the National Health and Aging Trends Survey (NHATS)<sup>18</sup>, a nationally representative survey of Medicare beneficiaries aged 65 years or older<sup>19</sup>; and the National Survey of Caregiving (NSOC)<sup>20</sup>, a survey of informal carers conducted in the United States of America (U.S.) in 2015 (round 5)<sup>21</sup>.

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<sup>17</sup> <https://drees.solidarites-sante.gouv.fr/etudes-et-statistiques/open-data/personnes-agees/article/les-enquetes-capacites-aides-et-ressources-des-seniors-care>

<sup>18</sup> <https://www.nhats.org/scripts/DataCollInstrPage.htm>

<sup>19</sup> Medicare beneficiaries ages 65 and older living in the contiguous United States in 2011 and in 2015. In follow-up years (e.g. 2012-2014, 2016-2018), the sample represents survivors of the original cross-section of interest.

<sup>20</sup> <https://www.nhats.org/scripts/DataCollInstrPageNSOC.htm>

<sup>21</sup> The initial sample was first interviewed in 2011. Replenishment of the sample to maintain its ability to represent the older Medicare population was undertaken in 2015.



The NHATS is a unique national resource for the scientific study of functioning in later life in the US.<sup>22</sup> The NHATS aimed at foster research that will design achievement to a diminished disability, enhance the health and independent functioning, and finally improve the quality of life of the elderly. NHATS participants provided information about all family/non-family carers who assisted with household chores, mobility tasks, or self-care activities.

The NSOC included 2,204 informal carers identified by the 8,334 NHATS participants in 2015. We considered as the primary carer, the person providing the most hours to the care recipient. The NHATS user guide contained further details and definitions of variables [55], and the NSOC user guide [56].<sup>23</sup> Informal carers participating in the NSOC were interviewed via telephone.

For our analysis, we combined both carers and recipients datasets based on the standard ID. Figure 2 represented the dyadic data with complete cases.

## **3.2. Variables**

### **3.2.1. Dependents variables**

The surveys *"CARE ménage"* and NHATS – NSOC provided information on the utilisation of support services. The majority of explanatory variables were selected based on the Andersen behavioural model applied to carers services utilisation [38,40,43,52]. We considered the use of support services as dependent variables. Carers answered "yes/no" to the questions as presented in the survey.

In France, we used the following variables, *"Can you give yourself some time off (period of respite)?" (Respite care)*. *"Have you participated in a support group to discuss the help you provide to take on your role as a carer?" (Support group)*. *"Do you think that (other) training would be useful to you in your role as a carer?" (Training)*. *"Do you regularly receive, because of your health status or your age, from a loved one - A financial support?" (Financial support)*.

In The U.S., we used the following variables, *"In the last year, have you used any service that took care of {SP} so that you could take some time away from helping?" (Respite care)*. *"In the last year, have you gone to a support group for people who give care?" (Support group)*. *"In the last year, have you received any training to help you take care of {SP}?" (Training)*. *"In the last year, have you found financial help for {SP}, including helping {him/her} apply for Medicaid {, also known as {STATE NAME FOR MEDICAID PROGRAM} in {SP STATE}}?" (Financial support)*.

### **3.2.2. Independent variables**

We are interested in formal care on support services utilisation by carers. Formal care indicates whether or not the care recipient had used support (in-home) for professional carers for some Activity of Daily

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<sup>22</sup> NHATS is being supported by the National Institute on Aging under a cooperative agreement with the Johns Hopkins University Bloomberg School of Public Health (U01AG032947), with data collection by Westat.

<sup>23</sup> <https://www.nhats.org/scripts/dataArchivedDocs.htm>

Living (ADL)<sup>24</sup> [57,58] or Instrumental Activity of Daily Living (IADL)<sup>25</sup> [59]. The survey question asked to the elderly person is: “for which activity did you receive one or more professional carers?” The formal care variable has the value one if the older adults receive one or more professional carers for ADL/IADL, and 0 otherwise. Our model control for factors: predisposing (filiation, cohabitation/co-residence, age), enabling (income, length of time for care), need (health status, the feeling of loneliness, lack of time, chronic diseases/conditions) [41].

We built a composite measure (*frailty*) related to informal care’s subjective burden based on care provision consequences [60]. This index captures the level of vulnerability related to caregiving outcome (mainly negative) but also depending on care provision intensity [61]. The composite measure reflects a linear combination of related indicators. These selected variables were turned into the *frailty* variable by computing the Principal Component Analysis (PCA), which substantially contributed to the main component.<sup>26</sup> The Principal Components Analysis related to the carers’ *frailty* comprised high values for the most affected. Subsequently, we used *Varimax* rotation to change the PCA coordinates that maximise the sum of the variances of the squared loadings. Thus, each component’s coefficients became either large or close to zero, with few intermediate values. Hence, the goal was to capture the association of each variable with at the most one factor.

### 3.3. Statistical and econometric analysis

Detailed information on informal carers and care recipients were provided through descriptive statistics. First, we used the test of independence and test of the mean difference between carers’ and recipients’ characteristics.<sup>27</sup> Secondly, we used multivariate modelling through equation (1), (2), (3) and (4) to explore the effect of formal care ( $FC_i$ ) and carers-recipients socio-demographic characteristics ( $X_i$ ) on support services utilisation (dichotomous variables). We estimated four different *probit* model, where  $a_k, b_k, c_k, d_k$  represents the parameters to be estimated in each equation, and  $\epsilon_i, \varphi_i, \delta_i, \pi_i$  represent the error terms. We estimated the following equations for France and the U.S.:

$$\text{Respite care}_i = a_0 + a_1FC_i + a_2X_i + \epsilon_i \quad (1)$$

$$\text{Support group}_i = b_0 + b_1FC_i + b_2X_i + \varphi_i \quad (2)$$

<sup>24</sup> As indicated in the survey report, ALD represent: bathing or showering; Dressing; eating; using the toilet; walking across a room; getting in or out of bed.

<sup>25</sup> As indicated in the survey report, IALD represent: shopping for groceries; preparing a hot meal; doing work around the house or garden; Administrative processes; taking medications; Get out of home or taking transportation or finding his way when out; using a phone.

<sup>26</sup> In keeping with the literature and the data collection, we selected the following as variables: physical fatigue; sleep disorders; morally tired or discouraged; sometimes feel alone; feel depressed; feel anxious, stressed, overworked; back problems; palpitations, tachycardia, etc.

<sup>27</sup> “Number of consequences of care provision” were split in two categories (“< 2” and “≥ 2”) to differentiate whether, there were an association between highly affected carers (“≥ 2” caregiving consequences) and their socio-demographics characteristics.

$$Training_i = c_0 + c_1FC_i + c_2X_i + \delta_i \quad (3)$$

$$Financial\ support_i = d_0 + d_1FC_i + d_2X_i + \pi_i \quad (4)$$

We performed the Hosmer-Lemeshow test (HL test) to check the goodness-of-fit (assuming the number of group = 10) [62] after the *probit* model.<sup>28</sup> We also calculate the Area Under the ROC<sup>29</sup> Curve (AUC)<sup>30</sup> to indicate the model's quality.

We first estimated our models considering formal care as an exogenous variable. However, this specification may reflect a biased predicted probability of support services utilisation due to the potential problem of endogeneity of formal care. Therefore, there might be an existing potential bias due to omitted variables or error measurement. Lastly, there is no denying that the possible *reverse causality* of formal care.

### 3.4. Instrumental variable (IV) approach

Theoretically, since we have identified a variable as endogenous (formal care), we need to find at least two different instruments (vector  $Z_i$ ), partially correlated with the formal care (endogenous regressor)  $Corr(FC_i, Z_i) \neq 0$  (hypothesis of relevance) and uncorrelated (orthogonal) with the error term  $Corr(\epsilon_i, Z_i) = 0$  (hypothesis of exogeneity) in the use of support services equation [63].

In the existing literature, instrumental variables (IV) approach was mostly developed for informal care in Europe [29,31,33,64,65], in the U.S. [35], and both Europe and the U.S. [27,28]. However, less concern on instrumental variables for formal care [66].

To our knowledge in France, Barnay and Juin, (2016) discussed the endogeneity and effect of formal care and informal care on the (mental) health of dependent older adults using the French Disability and Health Survey (*Enquête Handicap Santé Ménage*, 2008) [67]. They used “the proportion of daughters”, “having at least one child who has no child” to instrument the informal care. For formal care, “the percentage of individuals over 75 receiving the Personal Autonomy Allowance (PAA)<sup>31</sup> at the departmental level in 2008” instrument was used.

In the U.S., Spillman (2014) also treated in the endogeneity of informal care and formal care. The National Long-Term Care Survey (NLTCs)<sup>32</sup> data collected in 2004 were used to estimate the effect of

<sup>28</sup> A goodness of fit test shows how well the data fits the model. Specifically, the HL test calculates if the observed event rates match the expected event rates in population subgroups. The test is only used for binary response variables (a variable with two outcomes like the need for respite, yes or no).

<sup>29</sup> ROC stands for Receiver Operating Characteristic.

<sup>30</sup> The Area under ROC Curve (AUC) measure the entire two-dimensional area underneath the entire ROC curve from (0, 0) to (1, 1). AUC values ranges from 0 to 1. A model with a AUC equal to 0 mean prediction are 100% wrong, whereas as a model whose predictions are 100% correct has an AUC equal to 1.

<sup>31</sup> In French, *Allocation Personnalisée d'Autonomie (Apa)*.

<sup>32</sup> The NLTCs is nationally representative longitudinal survey focusing on disability and long-term care in the Medicare population age 65 or older for two decades prior to its discontinuation after the 2004 survey year.

informal care hours, formal care hours, and high carer stress on nursing home entry and expected days of care. Instruments were found for informal care, formal care, and carer stress. Mainly, variables like “the recipient lives alone”, “the number of daughters living within 1 hour of the recipient”, “primary carer has minor children” were used to instrument informal care. Lastly, three instruments such as “home health agencies per 1,000 persons 65 or over in county of residence”, “recipient lives in community residential care”, “the number of executive function-related limitations (out of 4)” were used for formal care.

Similarly, we selected various instruments for formal care received by care recipients in our study. This choice was guided by the literature [67,68]. In France, (i) Receiving the PAA; (ii) Mental Health Inventory (MHI 5); (iii) have at least one limitation for Activities of Daily Living (ADL). In the U.S., we used (i) live in community residential care, (ii) have at least one limitation for Activities of Daily Living (ADL). Therefore, the PAA seems to be a valid instrument because, in the majority, it is used by the care recipient to pay professional carers. Despite benefiting PAA, an average of 80€ per month remains paid by in-home dependent, beyond expenses included in assistance plans [69]. Assuming informal care and formal care are substitutes [28,35], informal care may reduce home health care utilisation and delays admission in the nursing home [35]. Finally, according to [68], recipient living in community residential care variable stands for a valid instrument for formal care.

The model with instrumental variables was used to solve endogeneity bias. Therefore, in Stata, the *ivprobit* program particularly estimates asymptotical efficient standard errors. Based on this econometric approach, the first-stage estimation considered the endogenous explanatory variable as a linear function of the instruments and the exogenous variables. The second stage estimation (Newey’s two-step estimator) included the prediction from the first stage as a covariate in the main equation, instead of using the endogenous explanatory variable. Alternatively, to the maximum likelihood estimation developed by default in Stata, we also performed the Neweys estimator with the “*twostep*” option [63,70].

To test for exogeneity, a Wald statistic, testing the correlation between the error term in the first stage and the error term in the primary model is not robust.<sup>33</sup> The test of over-identification was used to indicate the validity of instruments. Assuming there was no association between the IV and the error term in the second equation.<sup>34</sup> After estimating the model with IV, we performed the Amemiya–Lee–Newey statistics test results for over-identifying restrictions through the *overid* command [71,72].

Subsequently, considering the only endogenous regressor, we performed the “*rivtest*” program after instrumental-variables models whose robust to weak instruments. Instead of analysing the Lagrange

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<sup>33</sup>With a single instrument, it is not possible to test that it is indeed exogenous. Wald statistics are only comparable with weak instrument robust statistics when the Newey two-step estimator is used.

<sup>34</sup> Considering the test of over identification, the null hypothesis (Ho) stands for “The instruments are all exogenous”.

multiplier (LM) test and the J overidentification tests separately, we used the LM-J combination test, which tests the hypotheses of exogeneity of the instrument simultaneously.

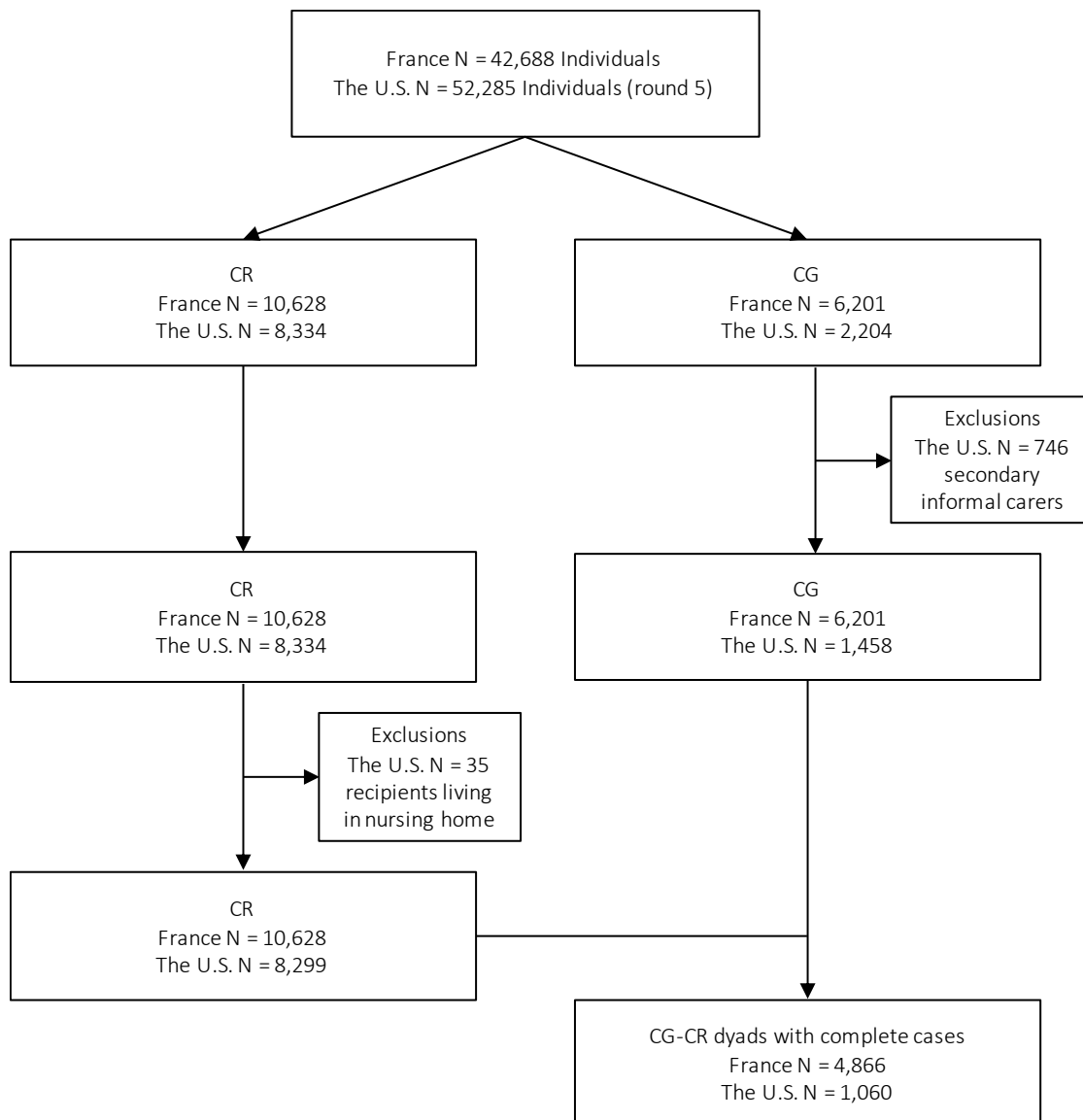
All statistical analyses were performed using STATA SE-64 Statistical software 14.2 (StataCorp. LP, College Station, TX, USA).

## **4. Results**

### **4.1. Descriptive statistics**

Figure 2 described the study sample based on N = 42,688 individuals in France and N = 52,285 individuals in the U.S. in 2015. In France, we found N = 10,628 care recipients, N = 6,201 informal carers. In the U.S., the NHATS survey indicates N = 8,334 care recipients (round 5), and N = 2,204 carers among which we excluded N = 746 others carers. Then, we only considered individuals who were primary carers. After merging carers-recipient data, the study sample indicates N = 6,201 dyads for France and N = 1,458 dyads in the U.S. Finally, N = 4,866 dyads for France and N = 1,060 dyads for the U.S. without missing data were used in the study.

**Figure 2: Study sample – France (N = 4,866) and the U.S. (N = 1,060)**



*Note CR care recipient; CG informal carer/caregiver; The U.S. The United States of America.*

Table 1 details carers’ characteristics distinguished by caregiving consequences more or less equal to two (fatigue, stress, etc.).

The majority of informal carers reported quite good health status. In the U.S, carers with excellent/good health status experienced more negative consequences. More than 60% married carers experienced several consequences due to caregiving, compared to single, divorced and widowed. The majority of female were carers and mostly affected by caregiving. The mean age of carers was 61 years in both countries with a slight range difference between France (range 18 - 96) and the U.S. (range 18 - 97). Care providers who reported several consequences of caregiving were less than 64 years old in both countries. A total of 40% informal carers have declared to be affected by at very least two negative consequences due to caregiving in France, compared to 74% in the U.S. The use of respite care was

different between countries: 75% of informal carers in France, compared to 18% in the U.S. Less than 4% carers in each country use a support group. Less than 10% of carers use training for care provision. Only 2% of carers received financial support in France, compared to 15% in the U.S. Carers cohabiting in France (56%) were more affected by caregiving than carers in the U.S. (38%). Less than Twenty-nine per cent care provider was the partner by marriage. The majority of carers were children, and those providing less than 30 hours per month in France were less affected by the care burden. Carers with the lack of time affected by caregiving consequences accounted for 55% in France and 58% in the U.S.

Table 2 described in details care recipients characteristics. More than 60% of recipients were aged 80 and over. Female recipient represented almost 68%. Almost 37% (N = 1,665) in France used formal care for ADL/IADL, while only 19% (N = 204) in the U.S. A large proportion of female recipients (nearly 70%) used formal care. Almost 82% of recipients with the worst health status used formal care in France, compared to 31% in the U.S. Recipients reported experiencing chronic conditions, such as high blood pressure (approximately 36% in France, and 32% in the U.S.), pain/chronic affections (26% in France, and 66 in the U.S.), Diabetes (19% in France, 15% in the U.S.), Osteoporosis (11%), Cancer (9% in France and 14% in the U.S.). The mean of the number of chronic diseases was approximately three in France and two in the U.S.

The *p-value* on the following (Table 1 and Table 2) indicated the existence of independence (or not) between the carer/care recipient characteristics.

Table 1: Descriptive statistics of the characteristics of the informal carers (CG)

	France				The U.S.			
	Entire population (N = 4, 866)	Number of consequences of care provision		p - value	Entire population (N = 1,060)	Number of consequences of care provision		p-value
		<2 (N = 2,944)	≥2 (N = 1,922)			<2 (N = 280)	≥2 (N = 780)	
Health status <sup>a</sup> %								
Very good and good	63	75	44	0.00	84	95	80	0.00
Fair, bad, and very bad	37	25	56		16	5	20	
Income <sup>b</sup> %, in quantiles								
Q1	30	28	32	0.00	23	29	25	0.03
Q2	24	24	25		27	24	28	
Q3	31	33	30		25	32	22	
Q4	15	16	13		25	24	25	
Marital status %								
Married	66	63	70	0.00	64	66	64	0.24
Single	19	21	16		13	15	13	
Divorced	5	6	4		16	13	17	
Widowed	10	10	10		7	5	7	
Sex %								
Female	60	55	69	0.00	67	71	66	0.1
Male	40	45	31		33	29	34	
Age, mean (SD)	61 (14)	59 (14)	64 (13.5)	0.00 <sup>e</sup>	61 (15)	60 (14.5)	62 (15)	0.16
Stress and anxiety %	32	7	70	0.00	36	2	48	0.00
Back problems/limited strength in hips %	21	3	49	0.00	29	3	39	0.00
Exhaustion %	30	5	67	0.00	29	2	38	0.00
Sleep disorders %	20	1	50	0.00	44	11	56	0.00
Feeling of loneliness %	39	25	60	0.00	16	2	21	0.00
Number of care provision consequences %								
< 2 consequences	60	-	-	-	26	-	-	-
≥ 2 consequences	40	-	-	-	74	-	-	-
Respite care %	75	73	80	0.00	18	15	19	0.16
Support group %	3	2	5	0.00	4	2	4	0.25
Training %	10	6	16	0.00	8	5	9	0.03
Financial support %	2	1	2	0.00	15	14	16	0.35



Table 1: Descriptive statistics of the characteristics of the informal carers (CG) (Continued)

	France				The U.S.			
	Entire population (N = 4, 866)	Number of consequences of care provision		p - value <sup>d</sup>	Entire population (N = 1,060)	Number of consequences of care provision		p-value
		<2 (N = 2,944)	≥2 (N = 1,922)			<2 (N = 280)	≥2 (N = 780)	
Cohabitation %	40	30	56	0.00	36	30	38	0.01
Filiation %								
Partner by marriage	29	20	42		27	19	29	
Child <sup>c</sup>	53	56	48	0.00	50	51	50	0.00
Family	13	16	8		17	21	16	
Close acquaintance	5	8	2		6	9	5	
Length of time providing care %								
< 1 years	5	4	5		8	8	8	
1 to 5 years	38	40	37	0.15	47	50	46	0.43
> 5 years	57	56	58		45	41	46	
Duration of care in hour/month <sup>f</sup> %								0.02
< 30H	48	61	29		19	20	19	
30H - 60H	17	17	17	0.00	19	21	18	0.29
60H - 150H	19	14	27		32	31	31	
> 150H	16	8	27		29	25	31	
Lack of time %	30	14	55	0.00	51	34	58	0.00
Profession %								
Retired	52	47	58		29	27	30	
Employed/Student	36	41	29	0.00	36	41	34	0.09
Unemployed/Inactive	12	12	13		35	32	36	
Carer receiving IC %	31	25	41	0.00	24	22	25	0.36
Education %								
High school/less	-	-	-		37	31	38	
Some post-high school	-	-	-	-	34	37	34	0.09
College degree/greater	-	-	-		29	32	28	

Notes: CR care recipient, SD standard deviation, IC Informal Care. <sup>a</sup> Health status: 5 categories recoded into two categories. <sup>b</sup> Income level: all categories divided into four quantiles; The variable Income for the U.S. is a continuous variable containing 47% missing observations; <sup>c</sup> Child: recoded item as daughter and son; <sup>d</sup> Chi2 statistical test; <sup>e</sup> Test of the difference of the means. The number of care provision consequences includes carers who reported: physical fatigue; sleep disorders; morally tired or discouraged; sometimes feel alone; feel depressed; feel anxious, stressed, overworked; back problems; palpitations, tachycardia. <sup>f</sup> We used the categorical variable of the time spent on care provision per month because of the prominence of missing values. Subsequently, we used monthly data concerning the time spent providing care rather than daily or weekly due to missing value (many respondents may also have refused to answer the questions during the survey).

Table 2: Descriptive statistics of the characteristics of the care recipients

	France				The U.S.			
	Entire population (N = 4,866)	Formal care use		P-value <sup>d</sup>	Entire population (N = 1,060)	Formal care use		P-value <sup>d</sup>
		No (N = 3,201)	Yes (N = 1,665)			No (N = 856)	Yes (N = 204)	
Age, mean (SD)	81 (9.5)	80 (9.3)	83 (9.4)	0.00 <sup>e</sup>	-	-	-	-
60 – 64 %	8	9	6		-	-	-	
65 – 69 %	8	10	6		6	7	3	
70 – 74 %	7	9	5		12	14	7	
75 – 79 %	16	17	12	0.00	17	18	10	0.00
80 – 84 %	19	21	17		20	21	16	
85 – 89 %	22	21	25		21	21	22	
> 90 %	19	14	27		22	18	42	
Sex %								
Female	68	67	70		67	67	69	
Male	32	33	30	0.09	33	33	31	0.00
Number of daughters, mean	0.04	0.04	0.05	0.02 <sup>e</sup>	1.7	1.8	1.5	0.00 <sup>e</sup>
PAA %	5	1	11	0.00	-	-	-	-
Formal care <sup>a</sup> %	37	-	-	-	19	-	-	-
Health status <sup>b</sup> %								
Very good and good	17	16	18		55	51	69	
Fair, bad, and very bad	83	84	82	0.22	45	49	31	0.00
Number of disease <sup>c</sup> , mean (SD)	3 (2)	2.4 (1.7)	4 (2.2)	0.00 <sup>e</sup>	1.6(1.9)	1.6(1.9)	1.4(1.8)	0.23

Table 2: Descriptive statistics of the characteristics of the care recipients (*Continued*)

	France				The U.S.			
	Entire population (N = 4,866)	Formal care use		P-value <sup>d</sup>	Entire population (N = 1,060)	Formal care use		P-value <sup>d</sup>
		No (N = 3,201)	Yes (N = 1,665)			No (N = 856)	Yes (N = 204)	
Disease/chronic conditions %								
Myocardial Infarction	3	3	4	0.00	9	10	7	0.16
High blood pressure	36	32	44	0.00	32	33	28	0.24
Stroke	4	2	9	0.00	11	12	9	0.18
Diabetes	19	15	26	0.00	15	16	11	0.09
Osteoporosis	11	8	15	0.00	11	12	11	0.9
Pain/chronic affections	26	22	35	0.00	66	67	60	0.04
Cataract	13	9	20	0.00	-	-	-	-
Bladder control problems (Incontinence)	13	7	24	0.00	-	-	-	-
Kidney problems	7	5	12	0.00	-	-	-	-
Parkinson's disease	2	1	5	0.00	-	-	-	-
Alzheimer Disease and other	1	0.2	3	0.00	10	10	11	0.60
Depression	14	9	24	0.00				
Cancer	9	7	13	0.00	14	14	16	0.46
ADL restrictions								
At least one %	20	21	20	0.36	14	14	16	0.45
Number (0 – 6), mean	0.5 (1.1)	0.5 (1.1)	0.5 (1.2)	0.92 <sup>e</sup>	0.4(1.3)	0	2.4(2.1)	0.00 <sup>e</sup>
IADL restrictions								
At least one %	68	68	69	0.42	13	0	70	0.00
Number (0 – 7), mean	1.8 (1.9)	1.8 (1.9)	1.8(1.9)	0.51 <sup>e</sup>	0.4(1.1)	0	2(1.8)	0.00 <sup>e</sup>
MHI-5 <sup>f</sup> , mean (SD)	66 (22)	72 (20)	56 (22)	0.00 <sup>e</sup>	-	-	-	-
Level of education %								
High school/less	82	82	83		-	-	-	-
Some post-high school	9	9	9	0.48	-	-	-	-
College degree/greater	9	9	8		-	-	-	-

Notes: SD standard deviation; <sup>a</sup> Proportion of elderly receiving formal care for ALD/IADL; <sup>b</sup> Health status: 5 categories recoded into two categories; <sup>c</sup> Number of chronic disease; <sup>d</sup> Chi2 statistical test; <sup>e</sup> Test of the difference of the means; <sup>f</sup> MHI-5: Mental-Health Inventory (0-100), with 100 representing the score of optimal mental health.

## 4.2. Econometrics model

### 4.2.1. Specification tests and instrumental validity

Table 3 and Table 4 summarise the results of the support services econometrics models (respite, support group, training, and financial support) without and with formal care treated as endogenous. Therefore, we also reported the model results, with statistics (LM-J test rejection indicator, Amemiya–Lee–Newey statistic (p-value) chi-square statistic, using “*twostep*” option). According to the LM-J over-identification test, the null hypothesis is not rejected at 5% level of significance in all models<sup>35</sup>. According to the econometric specification, at least one or quasi - majority instrument passed the over-identification tests. Therefore, instruments listed in section 3.4. (“benefit of PAA”; “MHI-5”; “recipient lives in community residential care”; “having at least one limitations”) variables were valid IV. Results indicated that the empirical model with instruments deemed better than the one without instruments.

Regarding the strength of instruments, it was not possible to test for the relevance of each IV. However, we argued that the quasi-majority of our IV were exogenous ( $p < 0.05$ ): (i) Receiving the PAA; (ii) the MHI5; (iii) Recipient lives in community residential care; (iv) Having at least one limitations. Appendix C provides the full estimation of the model treating the formal care as endogenous regressor with the maximum likelihood method. Regarding the first stage (Formal care) equation, the PAA was positive and significant ( $p < 0.01$ ) effect on the formal care. This finding underlies the principal assumption that recipients use effectively the majority of the financial support for the needs related to professional care. The level of limitations was positive and significant ( $p < 0.01$ ). Finally, improvement of mental health of the recipient significantly reduced the use of formal care ( $p < 0.01$ ). Regarding the U.S. results, the variables recipients living in community residential care and having at least one limitation imply using more formal care resources ( $p < 0.01$ ).

### 4.2.2. Formal care and support services utilisation by informal carers: Main results

*France.* Our findings show that for the entire carer population ( $N = 4,866$ ), the utilisation of formal care by the recipient did not affect the carer support services use. Then, the poorest health status for informal carers significantly increased their use of support services, especially for carers who received training ( $p < 0.05$ ) and financial support ( $p < 0.05$ ) compared to carers with excellent health status. Carers with the middle high-income level were likely to use respite, support group and training but were less likely to receive financial support ( $p < 0.05$ ). Informal carers providing care for a length of time greater than five years were more likely to use respite services. Moreover, being a child increased the use of respite ( $p < 0.01$ ) but reduced the use of support group ( $p < 0.01$ ) compared to partner by marriage.

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<sup>35</sup> Note the *overid* command in Stata performed the over identification test with the two-step method. Like Sargan and Basmann single-equation statistics, the test statistic is distributed as Chi-squared with (L-K) degrees of freedom under the null hypothesis that the instruments are valid.

The carers reporting a lack of time were more likely to use respite ( $p < 0.01$ ), a support group ( $p < 0.01$ ) and participate in training ( $p < 0.01$ ). The use of respite ( $p < 0.01$ ), a support group ( $p < 0.01$ ) and training ( $p < 0.01$ ) significantly increased with the age of the CG. However, the probability of receiving financial help reduced with age ( $p < 0.1$ ). We identified a nonlinear relationship between the age and the use of support services for carers; Which means, carers are less likely to use support services with ageing.

*The U.S.* Our findings show that care recipients' use of formal care increased the carers for respite utilisation ( $p < 0.05$ ). For a length of time greater than five years, the carers were more likely to need respite care ( $p < 0.1$ ). Being a child ( $p < 0.01$ ) and a family member ( $p < 0.1$ ) providing care was positively associated with inducing a use for respite care. Carers, who reported a lack of time were more likely to use respite care ( $p < 0.01$ ), a support group ( $p < 0.05$ ), and financial support ( $p < 0.1$ ). The age significantly increased the use of support services. This effect is particularly significant for the need for training ( $p < 0.1$ ) and those receiving financial support ( $p < 0.01$ ).

#### **4.2.3. Relationship between informal care and formal care: substitute or complement?**

In this section, we proceed at the empirical relationship between the formal care utilisation by the recipient and the informal care. Therefore, we empirically investigated the substitutability and complementarity relationship between informal and formal care. There appears no significant relationship between informal and formal care in France, even though formal care got a positive sign in the model. Results show that informal care and formal care were substitutable in the U.S. ( $p < 0.01$ ). Regarding instruments in the econometric model, it is worth to note that in France, recipients receiving PAA and having at least one limitations were more likely to use formal care ( $p < 0.05$ ). At the same time, we noticed an improvement of recipients mental health with formal care ( $p < 0.05$ ). In the U.S., it appears that living in community residential increases for recipients the use of formal care ( $p < 0.05$ ) (see Appendix A).

#### **4.2.4. Factors associate to carers subjective burden**

We analyse socio-economic and demographic characteristics associated with the frailty of carers. In the econometric model, we also included our dependent variables (support services use) to find an association with carers frailty. For both countries, it appears that the health status, the feeling of loneliness, and problem lack of time positively increase carers frailty ( $p < 0.01$ ). Conversely, the filiation (relationship) between carers and recipients produces a positive outcome by reducing the carer frailty ( $p < 0.1$ ) (see Appendix B).

Table 3: *Effect of formal care on support services utilisation by informal carers in France*

	Probit model without IV				Probit model with IV			
	(1) Respite care	(2) Support group	(3) Training	(4) Financial support	(1) Respite care	(2) Support group	(3) Training	(4) Financial support
Formal care (CR)	-0.041 (0.045)	0.060 (0.080)	0.035 (0.059)	0.078 (0.106)	0.051 (0.046)	-0.070 (0.090)	-0.010 (0.058)	-0.116 (0.120)
Health Status – ( <i>Very good</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Good	-0.043 (0.045)	-0.038 (0.080)	0.073 (0.059)	0.172 (0.106)	-0.041 (0.057)	-0.039 (0.108)	0.072 (0.075)	0.165 (0.171)
Fair	-0.018 (0.065)	0.038 (0.120)	0.312*** (0.084)	0.440** (0.176)	-0.019 (0.065)	0.042 (0.119)	0.311*** (0.083)	0.442** (0.176)
Bad	-0.148* (0.087)	0.205 (0.154)	0.373*** (0.113)	0.979*** (0.196)	-0.148* (0.087)	0.206 (0.149)	0.374*** (0.112)	0.974*** (0.189)
Very bad	-0.151 (0.210)	0.214 (0.368)	0.602** (0.236)	1.033*** (0.335)	-0.155 (0.214)	0.219 (0.354)	0.602** (0.258)	1.035*** (0.339)
Income Level – ( <i>Q1</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Q2	0.116** (0.054)	0.138 (0.102)	0.076 (0.072)	-0.217* (0.121)	0.114** (0.054)	0.141 (0.107)	0.076 (0.073)	-0.211* (0.123)
Q3	0.109** (0.052)	0.307*** (0.096)	0.169** (0.068)	-0.309** (0.124)	0.105** (0.052)	0.312*** (0.098)	0.170** (0.067)	-0.299** (0.126)
Q4	0.057 (0.064)	0.140 (0.126)	0.206** (0.082)	-0.131 (0.154)	0.060 (0.065)	0.137 (0.126)	0.205** (0.082)	-0.140 (0.154)
Length of time for care - ( <i>&lt;1 year</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
1 - 5 years	0.162* (0.091)	0.039 (0.170)	-0.050 (0.120)	-0.177 (0.210)	0.150 (0.092)	0.051 (0.169)	-0.045 (0.120)	-0.148 (0.215)
> 5 years	0.195** (0.090)	-0.123 (0.170)	-0.152 (0.119)	0.022 (0.202)	0.186** (0.090)	-0.113 (0.168)	-0.148 (0.118)	0.041 (0.206)
Filiation – ( <i>Partner by marriage</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Child	0.216*** (0.082)	-0.580*** (0.147)	0.163 (0.103)	0.069 (0.179)	0.202** (0.081)	-0.559*** (0.155)	0.168 (0.105)	0.093 (0.182)
Family member	0.150 (0.092)	-0.344** (0.163)	0.061 (0.120)	0.077 (0.197)	0.136 (0.092)	-0.322* (0.177)	0.068 (0.122)	0.102 (0.208)
Close acquaintance	-0.071 (0.110)	-0.172 (0.194)	0.114 (0.153)	0.423* (0.223)	-0.072 (0.109)	-0.166 (0.204)	0.115 (0.152)	0.417* (0.225)

Table 3: *Effect of formal care on support services utilisation by informal carers in France (Continued)*

	<i>Probit model without IV</i>				<i>Probit model with IV</i>			
	(1) Respite care	(2) Support group	(3) Training	(4) Financial support	(1) Respite care	(2) Support group	(3) Training	(4) Financial support
Cohabitation	-0.044 (0.066)	-0.109 (0.130)	-0.123 (0.079)	0.121 (0.146)	-0.040 (0.067)	-0.114 (0.133)	-0.124 (0.080)	0.109 (0.144)
Feeling of loneliness	-0.081* (0.043)	0.042 (0.076)	0.347*** (0.055)	-0.131 (0.100)	-0.081* (0.044)	0.042 (0.081)	0.346*** (0.056)	-0.127 (0.106)
Lack of time	0.167*** (0.046)	0.332*** (0.079)	0.368*** (0.056)	0.033 (0.107)	0.167*** (0.048)	0.328*** (0.081)	0.368*** (0.057)	0.033 (0.110)
Age, ln (CG)	5.076*** (1.563)	12.712*** (4.159)	5.060** (2.393)	-5.522* (2.930)	5.191*** (1.557)	12.572*** (4.120)	5.030** (2.149)	-5.652* (3.121)
Age, ln, squared (CG)	-0.641*** (0.201)	-1.653*** (0.520)	-0.733** (0.307)	0.662* (0.388)	-0.659*** (0.200)	-1.630*** (0.519)	-0.728*** (0.278)	0.684* (0.405)
Disease (CR)	-0.007 (0.010)	-0.031 (0.019)	-0.019 (0.014)	0.003 (0.023)	-0.018 (0.012)	-0.015 (0.023)	-0.015 (0.016)	0.026 (0.029)
Constant	-9.595*** (3.014)	-25.927*** (8.289)	-10.169** (4.616)	9.028* (5.415)	-9.760*** (2.997)	-25.740*** (8.145)	-10.139** (4.123)	9.192 (5.945)
Number of observations	4,866	4,866	4,866	4,866	4,866	4,866	4,866	4,866
Hosmer-Lemeshow - p-value <sup>(a)</sup>	0.10	0.54	0.34	0.32				
AUC	0.60	0.69	0.70	0.76				
LM-J test rejection indicator <sup>(b)</sup>					#	#	#	#
Amemiya–Lee–Newey p-value <sup>(c)</sup>					0.46	0.78	0.92	0.37

Note CR care recipient; Standard errors in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; (a) Hosmer-Lemeshow - goodness-of-fit statistic indicated the model good fit ( $p > 0.05$ ); Our models fit reasonably well on the validation sample. The models' discrimination in the validation sample is quite higher; Area Under ROC curve (AUC) denoted a good classifier;

The instrumental approach contains all the listed variables in table section 3.4; (b) '#' stand for "null hypothesis ( $H_0$ ) not rejected at 5% level" (the instruments are valid); (c) Amemiya–Lee–Newey statistic ( $p$ -value) chi-square statistic.

Table 4: *Effect of formal care on support services utilisation by informal carers in the U.S.*

	<i>Probit model without IV</i>				<i>Probit model with IV</i>			
	(1) Respite care	(2) Support group	(3) Training	(4) Financial support	(1) Respite care	(2) Support group	(3) Training	(4) Financial support
Formal care (CR)	0.242** (0.115)	0.369** (0.183)	0.132 (0.156)	0.076 (0.133)	0.034** (0.014)	0.026 (0.023)	0.001 (0.020)	0.011 (0.016)
Health Status – ( <i>Very good</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Good	0.059 (0.105)	0.109 (0.172)	0.324** (0.132)	0.009 (0.113)	0.058 (0.108)	0.104 (0.173)	0.329** (0.133)	0.015 (0.115)
Fair	-0.079 (0.139)	0.121 (0.212)	0.159 (0.164)	0.121 (0.135)	-0.079 (0.137)	0.117 (0.212)	0.150 (0.168)	0.126 (0.136)
Length of time for care - (<1 year)	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
1 - 5 years	0.212 (0.180)	-0.198 (0.266)	-0.197 (0.210)	0.045 (0.209)	0.232 (0.197)	-0.174 (0.270)	-0.207 (0.217)	0.050 (0.200)
> 5 years	0.376** (0.180)	-0.057 (0.265)	-0.129 (0.210)	0.281 (0.211)	0.383* (0.198)	-0.058 (0.269)	-0.143 (0.217)	0.282 (0.199)
Filiation – ( <i>Partner by marriage</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Child	0.698*** (0.206)	0.073 (0.298)	-0.192 (0.245)	-0.101 (0.209)	0.675*** (0.211)	0.108 (0.307)	-0.156 (0.258)	-0.108 (0.220)
Family member	0.430** (0.215)	0.159 (0.298)	-0.088 (0.253)	-0.170 (0.235)	0.412* (0.227)	0.187 (0.341)	-0.062 (0.284)	-0.174 (0.243)
Close acquaintance	0.293 (0.267)	0.417 (0.377)	-0.425 (0.331)	-0.007 (0.282)	0.259 (0.272)	0.461 (0.363)	-0.406 (0.375)	-0.031 (0.282)



Table 4: *Effect of formal care on support services utilisation by informal carers in the U.S. (Continued)*

	<i>Probit model without IV</i>				<i>Probit model with IV</i>			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Respite care	Support group	Training	Financial support	Respite care	Support group	Training	Financial support
Cohabitation	0.040 (0.155)	0.373* (0.225)	0.062 (0.192)	-0.080 (0.162)	0.037 (0.156)	0.382* (0.231)	0.068 (0.197)	-0.077 (0.166)
Feeling of loneliness	0.107 (0.129)	-0.133 (0.219)	0.041 (0.160)	0.054 (0.133)	0.117 (0.129)	-0.140 (0.222)	0.031 (0.158)	0.064 (0.135)
Lack of time	0.243** (0.096)	0.415*** (0.152)	0.177 (0.120)	0.182* (0.101)	0.247*** (0.096)	0.406** (0.164)	0.178 (0.122)	0.183* (0.101)
Age, ln (CG)	2.101 (3.630)	-0.267 (4.514)	7.361** (3.710)	11.488*** (3.365)	2.320 (3.652)	-0.829 (5.096)	6.935* (4.093)	11.770*** (3.529)
Age, ln, squared (CG)	-0.216 (0.469)	0.016 (0.589)	-1.042** (0.489)	-1.603*** (0.444)	-0.246 (0.472)	0.094 (0.666)	-0.982* (0.538)	-1.642*** (0.463)
Disease (CR)	0.020 (0.024)	-0.034 (0.037)	0.051* (0.028)	0.046* (0.025)	0.003 (0.024)	-0.047 (0.042)	0.044 (0.029)	0.037 (0.025)
Constant	-6.883 (6.966)	-1.416 (8.532)	-14.143** (6.991)	-21.395*** (6.354)	-7.237 (7.001)	-0.415 (9.638)	-13.389* (7.696)	-21.886*** (6.647)
Number of observations	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060
Hosmer-Lemeshow - p-value <sup>(a)</sup>	0.88	0.25	0.65	0.005				
AUC	0.70	0.68	0.66	0.68				
LM-J test rejection indicator <sup>(b)</sup>	-	-	-	-	#	#	#	#
Amemiya–Lee–Newey p value <sup>(c)</sup>	-	-	-	-	0.08	0.48	0.24	0.05

Note CR care recipient; Standard errors in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; (a) Hosmer-Lemeshow - goodness-of-fit statistic indicated the model good fit ( $p > 0.05$ ); Our models fit reasonably well on the validation sample. The models' discrimination in the validation sample is quite higher; Area Under ROC curve (AUC) denoted a good classifier; The instrumental approach contains all the listed variables in table section 3.4; (b) '#' stand for "null hypothesis ( $H_0$ ) not rejected at 5% level" (the instruments are valid); (c) Amemiya–Lee–Newey statistic (p-value) chi-square statistic. Note: the income variable contained 43% of missing observations and was not estimates. The variable "Health status" contained no observation on the categories "Bad" and "Very bad" in the final sample.

## 5. Discussion

Our study's main contribution was to empirically estimate how formal care affects the carer use of support services in France and the U.S. Our results indicated no significant effect of formal care on carer behaviour towards support services used in France. In contrast, formal care significantly increased the carer support services utilisation in the U.S., for instance, respite care.

Regarding our France results, no significant relationship was found between formal care and the carer uses of services. This result is all the more remarkable because no significant relationship was found between formal and informal care. Conversely, in the U.S, our study shows that carers of elderly who benefit from formal care were more likely to use support services. This evidence is an important point since formal and informal care are substitutable. Based on these remarks, it is worth noting that the health behaviour and carers utility within the care provision widely determine LTC arrangement decision. Second, there is no denying the complexity of the health system. Both France and the U.S., two highly rated health care system [73]<sup>36</sup>, where the proportion of elderly is growing steadily [74], have spent since 2002 more than 11% of GDP for health (France 11.3% and the U.S. 17.1%) [75]. Thus, both systems have got private insurance as well as government insurance (for instance, National Health Insurance (NHI) in France, and Medicare/Medicaid in the U.S.), the insurance scheme is provided through the employer [76]. A principal dissimilarity across health systems pointed out universal health coverage (UCH) in France. In the U.S., the health expenditure is paid by household (out-of-pocket), and almost 40% of the citizens do not have access to adequate health insurance. However, France has got the most expensive health care system in the world, but not as expensive as the U.S. system, which is the most costly [77].<sup>37</sup>

However, the Organisation for Economic Cooperation and Development (OECD) countries have different approaches for managing different care forms in LTC. It remains hard to precisely quantify how many countries differ in various formal and informal care [78]. The lack of information and data on the burden of care (intensity) may have limited research in some countries, where population ageing does not mean the same due to social norms [28]. Therefore, LTC policies in some OECD countries mostly rely on informal care and the cohesion inside the family. Subsequently, social norms and institutions quality and incentives seem to be the only driver behind the LTC arrangement. Since family cohesion has got a central place, and merely reflects policy, Barczyk and Kredler (2018) found that the U.S. has strong policies supporting informal care arrangements because informal care is of utmost importance.

Furthermore, the U.S. appears to be a reference where informal care precisely take place due to a limited LTC coverage, in contrast with the European –style culture of individualism [28]. The setting and

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<sup>36</sup> According the WHO report, France was the 1<sup>st</sup> whereas the U.S. was 37<sup>th</sup> regarding the overall health system performance.

<sup>37</sup> France spends about half of the U.S. for health care. In 2011, in France, spending came to \$3,359 per capita in PPP. The U.S. it was \$7,212 per capita in PPP.

implementation of LTC program were also quite particular regarding the framework and current health policy. Potential spending funds allocated in LTC does little to increase access to services in different countries in the same way. Therefore, if health policies want to continue to rely on informal care for LTC to maximise social welfare, more fund should be invested in the respite program targeting carers with frailty. Nevertheless, financial and in-kind assistance should also be provided to carers with a high informal care burden, even for vulnerable persons in the community.

A mapping of LTC in most OECD countries shows potential inequality regarding access to care [79]. While, some European countries face the problem of the low utilisation of support services by carers [80], in the U.S. barriers limit access to service utilisation. They might not always aware of various support services, in case of information asymmetries, but also when there are some barriers to services utilisation, awareness not always known by the support service itself [38]. Some support services remain underused because informal carers do not always identify themselves as informal carers; or they would have merely neglected the burden of care provision [81]. Then, access to information could remain one of the essential support needs for families to foster care provision efficiency [82], and ensure the social benefit through informal carers welfare [83]. Regarding the recipients, it appears the chronic condition (disease like Cancer, mental health, dementia, etc.) would influence predicting carers support services utilisation [52]. In the U.S. informal carers of elderly living with chronic diseases would have found positive utility with services such as training and financial support.

The instrumental validity indicated that the model with formal care as endogenous deemed relevant. The majority of control variables remained significant and kept the same sign in both models (when using instrumental variables or not). The two-step model, Amemiya–Lee–Newey statistic (p-value) and over-identification tests helped to validate instruments. The instrumental strategy results were then in line with some literature findings [67,68]. For instance, “PAA” and “MH15” in France [67]; and “recipient lives in community residential care” and “having at least one limitations” in the U.S. [68] were associated with formal care. Beyond two-stage least squares, our modelling also explored limited information maximum likelihood (more robust to weak instruments). These findings were quite similar to the two-steps model method. The LM-J statistics combination testing the hypothesis of exogeneity of instruments simultaneously was deemed more robust instead of two separate tests (Lagrange multiplier (LM) and J over-identification).

According to the Andersen model, factors such as predisposing (filiation, cohabitation/co-residence, age), enabling (income, length of time for care), need (health status, the feeling of loneliness, lack of time, chronic condition of the recipient) influence support services use. Previous findings indicated that predisposing and/or enabling factors were less closely associated with service utilisation than need factors. However, the findings show some inconsistencies in the strength and direction (sign) of the association. The econometric models based on the Andersen framework indicated that carers child were

more likely to use respite services. Intuitively, the use of services seems to increase with the ageing. That assumption was not verified in France, where the financial support was reduced with age. Thereby, these results could be explained by local organisation and community's existence to support family carers. Nevertheless, Potter (2018) indicated that demographic factor acting either as a predisposing or enabling factor were unimportant compared to other factors such as culture. Therefore, it would have appeared that Black or Hispanic are hesitant toward respite services.

Some limitations were identified throughout the study. First, we used subjective and dichotomous measurement of the use of support ("Yes" or "No"). Therefore, it was not possible to use and assess the different level of preferences of the use of support (*intensity* like, "No, not at all"; "Yes, a little bit"; "Yes, a lot. Future research should consider this point. Second, the analysis of the use of support choices of carers was assessed separately. The preferences for respite, support group, training, and financial support utilisation were not assumed in the compelled decision in which carers' characteristics were assessed conditionally. Our study did not explore the matter of barriers or bottleneck faced by carers toward support services utilisation. Geographical barriers differentiating the use of support services for carers-recipients have received very little attention in recent research. Future research should evaluate for policymakers different types of support that carers find most useful and pay attention to other potential sources of inequality and geographic variation in service utilisation in light of these results. In our surveys data, dependent variable, such as "training" would not have been formulated in the same way in both countries surveys questionnaires. These discrepancies may have indeed biased the answers and choices of carers. Therefore, based these inconsistencies, it is not easy to build a reliable comparison regarding this dependent variable in both countries; nevertheless, cautions should be taken.

## **6. Conclusion**

This study provides essential implications for Long-Term Care (TLC) dedicated to health policy, for an optimal trade-off between informal and formal care use, bearing in mind health system specificities. First, countries may spend more funds in innovative support programs in access to care, because some carers may have difficulties in accessing and using support services. Secondly, to provide and foster information campaigns to raise awareness concerning the utilisation of various existing health services, to improve and maximise social welfare. A prioritisation scheme for policymakers could consist of conducting studies to identify the population of carers at risk and provide assistance to those affected by the high burden due to informal care provision.

### **Conflict of interest**

None

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## Appendix

### Appendix A: Relation between Informal Care (IC) and Formal Care (FC)

	France		The U.S.	
	(1)	(2)	(1)	(2)
	Informal care	Formal care equation	Informal care	Formal care equation
Formal care	0.064 (0.091)		-0.048*** (0.010)	
<i>Instrumentals variables (IV)</i>				
PAA (CR)		1.054*** (0.109)		
MHI5 (CR)		-0.013*** (0.001)		
Having at least one limitations (CR)		0.807*** (0.047)		
Recipient lives in community residential care (CR)				0.804** (0.355)
Having at least one limitations (CR)				8.330*** (0.294)
Number of observations	4,866	4,866	1,060	1,060

Notes: CR care recipient; Results of the ordered logistic model (France and the U.S.) using the simultaneous equations model. This table summarises the joint estimations of IC, (Eq. (1), ordered probit model of informal care duration per month), and the formal care utilisation (Eq. (2), probit model) with the assumption that both equations have a multivariate error term distribution. The estimation technique is based on the “cmp” Stata package, Roodman, 2019 [84]. Dependent variables: Health Status; Income Level, Filiation; Cohabitation; Feeling of loneliness; Lack of time; Age (CG); Chronic disease (CR). Standard errors in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; Informal care: Duration of care per month in Hour.

### Appendix B: Factors associated with the frailty of informal carers

	France	The U.S.
	(1)	(2)
	Frailty	Frailty
Respite care	0.236*** (0.049)	0.061 (0.107)
Support group	0.337*** (0.120)	0.207 (0.221)
Training	0.546*** (0.071)	-0.121 (0.158)
Financial support	0.107 (0.163)	0.005 (0.117)
<i>Duration of care - (&lt;30H)</i>	<i>(ref.)</i>	<i>(ref.)</i>
30H-60H	0.103* (0.061)	-0.010 (0.131)
60H-150H	0.355*** (0.063)	0.052 (0.119)
>150H	0.687*** (0.074)	0.180 (0.122)

**Appendix B: Factors associated with the frailty of informal carers (Continued)**

	France	The U.S.
	(1)	(2)
	Frailty	Frailty
<i>Health Status – (Very good)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Good	0.259*** (0.059)	0.517*** (0.094)
Fair	0.955*** (0.067)	0.961*** (0.117)
Bad	1.599*** (0.093)	-
Very bad	1.789*** (0.233)	-
<i>Income Level – (Q1)</i>	<i>(ref.)</i>	-
Q2	-0.057 (0.057)	-
Q3	0.011 (0.055)	-
Q4	-0.053 (0.068)	-
<i>Length of time for care - (&lt;1 year)</i>	<i>(ref.)</i>	<i>(ref.)</i>
1 to 5 years	-0.069 (0.100)	-0.047 (0.155)
> 5 years	-0.021 (0.098)	-0.000 (0.156)
<i>Filiation - Partner by marriage</i>	<i>(ref.)</i>	<i>(ref.)</i>
Child	-0.310*** (0.085)	-0.320* (0.177)
Family member	-0.515*** (0.097)	-0.359* (0.191)
Close acquaintance	-0.769*** (0.118)	-0.421* (0.223)
Cohabitation	-0.005 (0.072)	0.027 (0.139)
Feeling of loneliness	0.745*** (0.046)	2.054*** (0.113)
Lack of time	1.196*** (0.051)	0.577*** (0.083)
ln, Age (CG)	3.735** (1.712)	6.652** (2.684)
ln, Age squared (CG)	-0.499** (0.220)	-0.934*** (0.351)
Disease (CR)	-0.002 (0.010)	0.019 (0.022)
Constant	-6.369* (3.301)	-12.351** (5.071)
Number of observations	4,866	1,060
R-Squared	0.414	0.391

Notes: CR care recipient. Results of the linear regression model (Multivariate analysis in France and the U.S.). The frailty variable (consequence) stand for the composite measure of the subjective burden. Section 2.2 indicates in details the measurement of this indicator. Standard errors in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; The table shows that variables such as health status; Filiation; Cohabitation; Feeling of loneliness; Lack of time; Age were significant in both countries.

## Appendix C: IV model - Formal care effect on the need for support of informal carers

	France				The U.S.			
	(1) Respite care	(2) Support group	(3) Training	(4) Financial support	(1) Respite care	(2) Support group	(3) Training	(4) Financial support
Formal care (CR)	0.051 (0.046)	-0.070 (0.090)	-0.010 (0.058)	-0.116 (0.120)	0.034** (0.014)	0.026 (0.023)	0.001 (0.020)	0.011 (0.016)
Health Status – ( <i>Very good</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Good	-0.041 (0.057)	-0.039 (0.108)	0.072 (0.075)	0.165 (0.171)	0.058 (0.108)	0.104 (0.173)	0.329** (0.133)	0.015 (0.115)
Fair	-0.019 (0.065)	0.042 (0.119)	0.311*** (0.083)	0.442** (0.176)	-0.079 (0.137)	0.117 (0.212)	0.150 (0.168)	0.126 (0.136)
Bad	-0.148* (0.087)	0.206 (0.149)	0.374*** (0.112)	0.974*** (0.189)	- (-)	- (-)	- (-)	- (-)
Very bad	-0.155 (0.214)	0.219 (0.354)	0.602** (0.258)	1.035*** (0.339)	- (-)	- (-)	- (-)	- (-)
Income Level – ( <i>Q1</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Q2	0.114** (0.054)	0.141 (0.107)	0.076 (0.073)	-0.211* (0.123)	- (-)	- (-)	- (-)	- (-)
Q3	0.105** (0.052)	0.312*** (0.098)	0.170** (0.067)	-0.299** (0.126)	- (-)	- (-)	- (-)	- (-)
Q4	0.060 (0.065)	0.137 (0.126)	0.205** (0.082)	-0.140 (0.154)	- (-)	- (-)	- (-)	- (-)
Length of time for care – (<1 year)	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
1 - 5 years	0.150 (0.092)	0.051 (0.169)	-0.045 (0.120)	-0.148 (0.215)	0.232 (0.197)	-0.174 (0.270)	-0.207 (0.217)	0.050 (0.200)
> 5 years	0.186** (0.090)	-0.113 (0.168)	-0.148 (0.118)	0.041 (0.206)	0.383* (0.198)	-0.058 (0.269)	-0.143 (0.217)	0.282 (0.199)
Filiation – ( <i>Partner by marriage</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Child	0.202** (0.081)	-0.559*** (0.155)	0.168 (0.105)	0.093 (0.182)	0.675*** (0.211)	0.108 (0.307)	-0.156 (0.258)	-0.108 (0.220)
Family member	0.136 (0.092)	-0.322* (0.177)	0.068 (0.122)	0.102 (0.208)	0.412* (0.227)	0.187 (0.341)	-0.062 (0.284)	-0.174 (0.243)
Close acquaintance	-0.072 (0.109)	-0.166 (0.204)	0.115 (0.152)	0.417* (0.225)	0.259 (0.272)	0.461 (0.363)	-0.406 (0.375)	-0.031 (0.282)
Cohabitation	-0.040 (0.067)	-0.114 (0.133)	-0.124 (0.080)	0.109 (0.144)	0.037 (0.156)	0.382* (0.231)	0.068 (0.197)	-0.077 (0.166)
Feeling of loneliness	-0.081* (0.044)	0.042 (0.081)	0.346*** (0.056)	-0.127 (0.106)	0.117 (0.129)	-0.140 (0.222)	0.031 (0.158)	0.064 (0.135)
Lack of time	0.167*** (0.048)	0.328*** (0.081)	0.368*** (0.057)	0.033 (0.110)	0.247*** (0.096)	0.406** (0.164)	0.178 (0.122)	0.183* (0.101)
Ln, Age (CG)	5.191*** (1.557)	12.572*** (4.120)	5.030** (2.149)	-5.652* (3.121)	2.320 (3.652)	-0.829 (5.096)	6.935* (4.093)	11.770*** (3.529)
Ln, Age squared (CG)	-0.659*** (0.200)	-1.630*** (0.519)	- (0.278)	0.684* (0.405)	-0.246 (0.472)	0.094 (0.666)	-0.982* (0.538)	-1.642*** (0.463)
Disease (CR)	-0.018 (0.012)	-0.015 (0.023)	-0.015 (0.016)	0.026 (0.029)	0.003 (0.024)	-0.047 (0.042)	0.044 (0.029)	0.037 (0.025)
Constant	-9.760*** (2.997)	-25.740*** (8.145)	- (4.123)	9.192 (5.945)	-7.237 (7.001)	-0.415 (9.638)	13.389* (7.696)	-21.886*** (6.647)
<b>Formal care Equation</b>								
Health Status – ( <i>Very good</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>
Good	-0.026 (0.045)	-0.026 (0.045)	-0.026 (0.045)	-0.026 (0.045)	0.200* (0.102)	0.200* (0.102)	0.200* (0.102)	0.200* (0.102)
Fair	0.057 (0.051)	0.058 (0.051)	0.058 (0.051)	0.057 (0.051)	-0.021 (0.127)	-0.021 (0.127)	-0.020 (0.127)	-0.019 (0.127)
Bad	-0.001 (0.070)	-0.001 (0.070)	-0.001 (0.070)	-0.001 (0.070)	- (-)	- (-)	- (-)	- (-)
Very bad	0.058 (0.177)	0.058 (0.177)	0.058 (0.177)	0.058 (0.177)	- (-)	- (-)	- (-)	- (-)
Income Level – ( <i>Q1</i> )	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	<i>(ref.)</i>	-	-	-	-
Q2	0.036 (0.043)	0.036 (0.043)	0.036 (0.043)	0.036 (0.043)	- (-)	- (-)	- (-)	- (-)
Q3	0.090** (0.041)	0.090** (0.041)	0.090** (0.041)	0.090** (0.041)	- (-)	- (-)	- (-)	- (-)
Q4	-0.029 (0.051)	-0.029 (0.051)	-0.029 (0.051)	-0.029 (0.051)	- (-)	- (-)	- (-)	- (-)



**Appendix C: IV model - Formal care effect on the need for support of informal carers (Continued)**

	France				The U.S.			
	(1) Respite care	(2) Support group	(3) Training	(4) Financial support	(1) Respite care	(2) Support group	(3) Training	(4) Financial support
Length of time for care - (<1 year)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)
1 - 5 years	0.112 (0.076)	0.112 (0.076)	0.112 (0.076)	0.112 (0.076)	-0.286* (0.169)	-0.286* (0.169)	-0.286* (0.169)	-0.285* (0.169)
> 5 years	0.088 (0.074)	0.088 (0.074)	0.088 (0.074)	0.088 (0.074)	-0.197 (0.170)	-0.198 (0.170)	-0.197 (0.170)	-0.196 (0.170)
Filiation – (Partner by marriage)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)	(ref.)
Child	0.139** (0.065)	0.139** (0.065)	0.139** (0.065)	0.139** (0.065)	0.214 (0.194)	0.214 (0.194)	0.214 (0.194)	0.213 (0.194)
Family member	0.156** (0.073)	0.156** (0.073)	0.156** (0.073)	0.156** (0.073)	0.148 (0.208)	0.148 (0.208)	0.147 (0.208)	0.147 (0.208)
Close acquaintance	0.067 (0.089)	0.067 (0.089)	0.067 (0.089)	0.067 (0.089)	0.107 (0.246)	0.107 (0.246)	0.107 (0.246)	0.109 (0.246)
Cohabitation	-0.023 (0.052)	-0.023 (0.052)	-0.023 (0.052)	-0.023 (0.052)	0.016 (0.152)	0.016 (0.152)	0.016 (0.152)	0.016 (0.152)
Feeling of loneliness	0.024 (0.035)	0.024 (0.035)	0.024 (0.035)	0.024 (0.035)	-0.214* (0.123)	-0.214* (0.123)	-0.214* (0.123)	-0.214* (0.123)
Lack of time	-0.045 (0.037)	-0.045 (0.037)	-0.045 (0.037)	-0.045 (0.037)	0.108 (0.090)	0.108 (0.090)	0.108 (0.090)	0.107 (0.090)
In, Age (CG)	-0.376 (1.295)	-0.377 (1.295)	-0.378 (1.295)	-0.376 (1.295)	-0.044 (2.931)	-0.044 (2.931)	-0.034 (2.931)	-0.017 (2.931)
In, Age squared (CG)	0.080 (0.166)	0.080 (0.166)	0.080 (0.166)	0.080 (0.166)	0.026 (0.384)	0.026 (0.384)	0.024 (0.384)	0.022 (0.384)
Disease (CR)	0.069*** (0.009)	0.069*** (0.009)	0.069*** (0.009)	0.069*** (0.009)	-0.020 (0.024)	-0.020 (0.024)	-0.020 (0.024)	-0.021 (0.024)
<i>Instruments (IV)</i>								
PAA (CR)	0.069*** (0.009)	0.069*** (0.009)	0.069*** (0.009)	0.069*** (0.009)	-	-	-	-
MHIS (CR)	-0.007*** (0.001)	-0.007*** (0.001)	-	-0.007*** (0.001)	-	-	-	-
Having at least one limitations	0.403*** (0.034)	0.405*** (0.034)	0.404*** (0.034)	0.403*** (0.034)	8.334*** (0.147)	8.334*** (0.147)	8.328*** (0.147)	8.319*** (0.147)
Recipient lives in community residential care	-	-	-	-	0.796*** (0.181)	0.796*** (0.181)	0.807*** (0.181)	0.827*** (0.181)
Constant	0.461 (2.502)	0.460 (2.502)	0.463 (2.502)	0.460 (2.502)	-0.143 (5.532)	-0.142 (5.532)	-0.159 (5.531)	-0.188 (5.532)
Number of observations	4,866	4,866	4,866	4,866	1,060	1,060	1,060	1,060

Note CR care recipient. This table estimates the formal home's care effect on support services utilisation by informal carers based on instrumental variables (IV). Wald test not robust to weak instruments when performing IV model with maximum likelihood. We checked this by using other tests like the LM-J over-identification and the Amemiya–Lee–Newey statistic using the two-step method (An alternative method which produces similar results). Standard errors in parentheses; \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ;

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