**Supplementary Material**

**Assessing Quality of Life, Economic Burden, and Independence Across the Alzheimer’s Disease Continuum Using Patient-Caregiver Dyad Surveys**

**Supplementary Table 1.** Components of the patient and caregiver surveys

|  |  |  |
| --- | --- | --- |
|  | **Patient survey** | **Caregiver survey** |
| **Demographics and contextual features** |  |  |
| Baseline demographics (age, sex, state, race/ ethnicity, relationship status, educational level) | ✓ | ✓ |
| Living situation | ✓ | ✓ |
| Comorbidities | ✓ | ✓ (abbreviated list) |
| Clinical information (AD diagnosis, falls) | ✓ |  |
| Nursing home status | ✓ |  |
| Caregiving information (relationship to patient, caregiving time provided including unpaid care) |  | ✓ |
| **Employment and productivity** |  |  |
| Employment information (income, employment status, change in jobs, replacement at work) | ✓ | ✓ |
| Work productivity (missed workdays, health problems affecting productivity) |  | ✓ (WPAI) |
| **Quality of life and dependence** |  |  |
| Patient QoL | ✓ (bespoke questions) | ✓ (DEMQOL-Proxy) |
| Caregiver QoL |  | ✓ (CarerQoL-7D) |
| Dependence of patient |  | ✓ (DS) |

AD, Alzheimer’s disease; CarerQoL-7D, Care-related Quality of Life-7 dimensions instrument; DEMQOL-Proxy, Dementia Quality of Life Proxy Questionnaire; DS, Dependence Scale; QoL, quality of life; WPAI, Work Productivity and Activity Impairment.

**Supplementary Table 2.** Response to patient survey

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **MCI****N=27** | **Mild AD****N=27** | **Moderate AD****N=25** | **Severe AD****N=21** | **Total AD****N=73** |
| **Who is answering the questions of the patient questionnaire?**PatientCaregiver | 27 (100.0%)0 (0.0%) | 26 (96.3%)1 (3.7%) | 21 (84.0%)4 (16.0%) | 15 (71.4%)6 (28.6%) | 62 (84.9%)11 (15.1%) |

AD, Alzheimer’s disease; MCI, mild cognitive impairment.

**Supplementary Table 3.** Geographic distribution of patients and their caregivers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **MCI****N=27** | **Mild AD****N=27** | **Moderate AD****N=25** | **Severe AD****N=21** | **Total AD****N=73** |
| MidwestNortheastSoutheastSouthwestWest | 6 (22.2%)10 (37.0%)6 (22.2%)5 (18.5%)0 (0.0%) | 1 (3.7%)8 (29.6%)12 (44.4%)5 (18.5%)1 (3.7%) | 1 (4.0%)13 (52.0%)9 (36.0%)2 (8.0%)0 (0.0%) | 1 (4.8%)12 (57.1%)1 (4.8%)3 (14.3%)4 (19.0%) | 3 (4.1%)33 (45.2%)22 (30.1%)10 (13.7%)5 (6.8%) |

AD, Alzheimer’s disease; MCI, mild cognitive impairment.

**Supplementary Table 4.** Background Characteristics of Caregivers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **MCI****N=27** | **Mild AD****N=27** | **Moderate AD****N=25** | **Severe AD****N=21** | **Total AD****N=73** |
| **Age (y)** 30–34 35–39 40–44 45–49 50–54 55–59 60–64 65–69 70–74 75+ | 3 (11.1%)2 (7.4%)3 (11.1%)2 (7.4%)0 (0.0%)4 (14.8%)2 (7.4%)8 (29.6%)1 (3.7%)2 (7.4%) | 0 (0.0%)0 (0.0%)2 (7.4%)2 (7.4%)1 (3.7%)3 (11.1%)4 (14.8%)7 (25.9%)4 (14.8%)4 (14.8%) | 1 (4.0%)6 (24.0%)4 (16.0%)2 (8.0%)1 (4.0%)0 (0.0%)2 (8.0%)6 (24.0%)1 (4.0%)2 (8.0%) | 1 (4.8%)3 (14.3%)7 (33.3%)0 (0.0%)1 (4.8%)0 (0.0%)2 (9.5%)5 (23.8%)1 (4.8%)1 (4.8%) | 2 (2.7%)9 (12.3%)13 (17.8%)4 (5.5%)3 (4.1%)3 (4.1%)8 (11.0%)18 (24.7%)6 (8.2%)7 (9.6%) |
| **Gender** Female | 21 (77.8%) | 16 (59.3%) | 16 (64.0%) | 12 (57.1%) | 44 (60.3%) |
| **Race/ethnicity:**  White Black Asian Hispanic | 18 (66.7%)5 (18.5%)3 (11.1%)1 (3.7%) | 18 (66.7%)5 (18.5%)2 (7.4%)2 (7.4%) | 15 (60.0%)4 (16.0%)2 (8.0%)4 (16.0%) | 19 (90.5%)1 (4.8%)0 (0.0%)1 (4.8%) | 52 (71.2%)10 (13.7%)4 (5.5%)7 (9.6%) |
| **Highest educational level**No formal education Less than high school High school Some college College graduate Post college | 0 (0.0%)0 (0.0%)3 (11.1%)9 (33.3%)14 (51.9%)1 (3.7%) | 1 (3.7%)0 (0.0%)9 (33.3%)8 (29.6%)8 (29.6%)1 (3.7%) | 0 (0.0%)0 (0.0%)6 (24.0%)6 (24.0%)13 (52.0%)0 (0.0%) | 0 (0.0%)0 (0.0%)5 (23.8%)8 (38.1%)8 (38.1%)0 (0.0%) | 1 (1.4%)0 (0.0%)20 (27.4%)22 (30.1%)29 (39.7%)1 (1.4%) |
| **Marital status** Married/Civil partnership Never married Widowed Separated/Divorced Prefer not to say/unknown | 18 (66.7%)2 (7.4%)1 (3.7%)4 (14.8%)2 (7.4%) | 22 (81.5%)0 (0.0%)1 (3.7%)4 (14.8%)0 (0.0%) | 22 (88.0%)2 (8.0%)0 (0.0%)1 (4.0%)0 (0.0%) | 17 (81.0%)2 (9.5%)0 (0.0%)1 (4.8%)1 (4.8%) | 61 (83.6%)4 (5.5%)1 (1.4%)6 (8.2%)1 (1.4%) |
| **Relationship to the person providing care for** Spouse Relative (sibling, child, in-law) Friend  Paid caregiver | 11 (40.7%)11 (40.7%)2 (7.4%)3 (11.1%) | 16 (59.3%)9 (33.3%)1 (3.7%)1 (3.7%) | 10 (40.0%)7 (28.0%)1 (4.0%)7 (28.0%) | 7 (33.3%)4 (19.0%)0 (0.0%)10 (47.6%) | 33 (45.2%)20 (27.4%)2 (2.7%)18 (24.7%) |
| **Living in the same home/apartment as person providing care for** Yes, live together No, live separately | 15 (55.6%)12 (44.4%) | 23 (85.2%)4 (14.8%) | 13 (52.0%)12 (48.0%) | 8 (38.1%)13 (61.9%) | 44 (60.3%)29 (39.7%) |
| **Time providing care (y),** mean ± SD | 3.0 ± 5.7 | 2.1 ± 1.3 | 2.3 ± 1.8 | 2.3 ± 1.6 | 2.2 ± 1.6 |
| **Hours per week providing assistance, care, supervision, or companionship (in the last 3 months),** mean ± SD | 52.9 ± 44.0 | 49.9 ± 26.7 | 51.3 ± 38.4 | 64.7 ± 46.9 | 54.6 ± 37.5 |
| **Of those, unpaid hours,** mean ± SD | 39.7 ± 42.5 | 48.1 ± 28.6 | 37.9 ± 46.5 | 48.9 ± 58.5 | 44.8 ± 44.6 |

Values are expressed as n (%) unless otherwise noted. AD, Alzheimer’s disease; MCI, mild cognitive impairment.

**Supplementary Table 5.** Parameter estimates for final models.

| **Parameter** | **Estimate** | **SE** | **95% CI** | ***p*** |
| --- | --- | --- | --- | --- |
|  | Final model for DEMQOL-Proxy scores |
| Intercept | 96.7265 | 22.3201 | 52.9799 | 140.4731 | **<0.01** |
| Severity | 7.6374 | 6.8226 | -5.7346 | 21.0095 | 0.26 |
| Severity\*Severity | -3.7521 | 1.3355 | -6.3697 | -1.1345 | **<0.01** |
| Sex (female versus male) | -47.3560 | 29.6915 | -105.550 | 10.8381 | 0.11 |
| Employment (employed versus other) | 6.5222 | 6.1644 | -5.5599 | 18.6043 | 0.29 |
| Agea | -0.0271 | 0.2949 | -0.6051 | 0.5510 | 0.93 |
| Marital status (married versus other) | -14.6526 | 6.5528 | -27.4958 | -1.8095 | **0.03** |
| Age\*Sex (female) | 0.5954 | 0.4087 | -0.2056 | 1.3964 | 0.15 |
| Severity\*Marital status (married) | 5.7210 | 2.5786 | 0.6671 | 10.7749 | **0.03** |
| Scale | 12.9687 | 0.9170 | 11.2903 | 14.8965 |  |
|  | Final model for CarerQoL-7D utility scores |
| Intercept | 68.6681 | 12.3258 | 44.5101 | 92.8261 | **<0.01** |
| Severity | -0.4346 | 1.0187 | -2.4313 | 1.5621 | 0.67 |
| Sex (female versus male) | 20.6731 | 10.1454 | 0.7885 | 40.5576 | **0.04** |
| Agea  | 0.0962 | 0.1799 | -0.2564 | 0.4488 | 0.59 |
| Employment (employed versus other) | 4.0083 | 3.7624 | -3.3660 | 11.3825 | 0.29 |
| Age\*sex (female) | -0.2990 | 0.1682 | -0.6286 | 0.0306 | 0.08 |
| Scale | 10.6476 | 0.7529 | 9.2697 | 12.2304 |  |
|  | Final model for DS |
| Intercept | -1.4557 | 4.6291 | -10.5286 | 7.6172 | 0.75 |
| Severity | -4.0046 | 1.3879 | -6.7248 | -1.2845 | **<0.01** |
| Severity\*Severity | 1.0802 | 0.2769 | 0.5376 | 1.6229 | **<0.01** |
| Sex (female versus male) | 15.1678 | 6.0788 | 3.2536 | 27.0821 | **0.01** |
| Agea | 0.1596 | 0.0614 | 0.0392 | 0.2799 | **0.01** |
| Employment (employed versus other) | -2.1643 | 1.2722 | -4.6576 | 0.3291 | 0.09 |
| Diabetes (yes versus no) | -0.9985 | 0.6244 | -2.2223 | 0.2253 | 0.11 |
| Age\*sex (female) | -0.2032 | 0.0834 | -0.3668 | -0.0397 | **0.01** |
| Scale | 2.7003 | 0.1909 | 2.3509 | 3.1017 |  |
|  | Final model for indirect costs to caregivers |
| Intercept | -1048.95 | 806.8718 | -2630.39 | 532.4867 | 0.19 |
| Severity | 480.3808 | 305.9919 | -119.352 | 1080.114 | 0.12 |
| Sex (female versus male) | 330.3435 | 355.3804 | -366.189 | 1026.876 | 0.35 |
| Marital status (married) | 1304.962 | 880.5805 | -420.944 | 3030.868 | 0.14 |
| Employment (employed versus other) | 1621.447 | 394.2447 | 848.7415 | 2394.152 | **<0.01** |
| Hours providing care | 22.5994 | 4.8232 | 13.1461 | 32.0527 | **<0.01** |
| Severity\*Marital status (married) | -872.648 | 352.0771 | -1562.71 | -182.590 | **0.01** |
| Scale | 1602.774 | 113.3332 | 1395.350 | 1841.032 |  |
|  | Final model for costs to employers |
| Intercept | 289.8960 | 862.9245 | -1401.41 | 1981.197 | 0.74 |
| Severity | 719.6106 | 360.9872 | 12.0886 | 1427.133 | **<0.05** |
| Marital status caregiver (married) | 1002.194 | 1019.378 | -995.751 | 3000.139 | 0.33 |
| Severity\*Marital status caregiver (married) | -902.817 | 413.1615 | -1712.60 | -93.0359 | **0.03** |
| Scale | 1903.657 | 134.6089 | 1657.294 | 2186.642 |  |
|  | Final model for intangible costs to patients |
| Intercept | 1242.766 | 373.8380 | 510.0572 | 1975.475 | **<0.01** |
| Severity | 392.9661 | 114.2839 | 168.9738 | 616.9583 | **<0.01** |
| Sex (female versus male) | 245.2409 | 264.6072 | -273.380 | 763.8614 | 0.35 |
| Employment (employed versus other) | -588.525 | 571.0506 | -1707.76 | 530.7141 | 0.30 |
| Heart attack (yes versus no) | -456.087 | 318.6356 | -1080.60 | 168.4273 | 0.15 |
| Diabetes (yes versus no) | -651.735 | 279.5514 | -1199.65 | -103.824 | **0.02** |
| Scale | 1218.555 | 86.1649 | 1060.855 | 1399.697 |  |
|  | Final model for intangible costs to caregivers |
| Intercept | 2928.951 | 2250.366 | -1481.69 | 7339.589 | 0.19 |
| Severity  | -1509.97 | 856.8498 | -3189.37 | 169.4205 | 0.08 |
| Sex (female versus male) | -314.944 | 226.2271 | -758.341 | 128.4530 | 0.16 |
| Years of educationb | -140.094 | 138.2629 | -411.084 | 130.8965 | 0.31 |
| Agea | 4.1656 | 12.7472 | -20.8184 | 29.1496 | 0.74 |
| Employment (employed versus other) | -327.620 | 362.1051 | -1037.33 | 382.0931 | 0.37 |
| Severity\*Years of education | 108.5771 | 58.4732 | -6.0284 | 223.1825 | 0.06 |
| Scale | 1026.057 | 72.5532 | 893.2697 | 1178.584 |  |
|  | Final model for summed costsc |
| Intercept | -1459.86 | 2493.137 | -6346.32 | 3426.598 | 0.56 |
| Severity  | 2361.290 | 559.9530 | 1263.803 | 3458.778 | **<0.01** |
| Years of education patientb | 246.9296 | 156.4625 | -59.7312 | 553.5904 | 0.11 |
| Marital status patient (married) | -2265.03 | 712.0279 | -3660.58 | -869.478 | **<0.01** |
| Marital status caregiver (married) | 5196.097 | 1675.639 | 1911.904 | 8480.289 | **<0.01** |
| Severity\*Marital status caregiver (married) | -2355.51 | 643.2824 | -3616.32 | -1094.70 | **<0.01** |
| Scale | 2906.857 | 205.5458 | 2530.665 | 3338.971 |  |

AD, Alzheimer’s disease; CI, confidence interval; DEMQOL, Dementia Quality of Life; DS, dependence scale; CarerQoL-7D, Care-related Quality of Life – 7 dimensions; MCI, mild cognitive impairment; SE, standard error.

aAge groups were transformed into continuous values by using the center value of each age group. b Educational levels were transformed to years of education. cSummed costs include indirect costs to caregivers, costs to employers, and intangible costs to patients and to caregivers.

**Supplementary Table 6.** Association Between Patient Answers to QoL Questions and DEMQOL-Proxy Scores.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Estimate±SE** | **95% CI** | **p** |
| **Q38: In the last week, I have felt inferior to other people** | 2.5 ± 1.3 | -0.1, 5.0 | 0.59 |
| **Q39: In the last week, I have felt embarrassed about myself** | 5.6±1.6a | 2.3, 8.8 | **<0.01** |
| **Q40: In the last week, I have worried about not playing a useful part in things (e.g., participating in volunteer work or politics, helping others)** | 5.4±1.4a | 2.6, 8.2 | **<0.01** |
| **Q41: In the last week, I have felt that I do not want to be in the company of people** | 3.3±1.3a | 0.66, 5.9 | **0.01** |
| **Q42: Since my diagnosis of Alzheimer’s disease or mild cognitive impairment, people have treated me unfairly or have spoken to me unkindly** | 4.8±1.3a | 2.3, 7.3 | **<0.01** |
| **Q43: Since my diagnosis of Alzheimer’s disease or mild cognitive impairment, I have been the victim of physical or psychological abuse** | 4.0±1.2a | 1.6, 6.4 | **0.01** |
| **Q44: In the last week, I have been unable to access information or news** | 5.2±1.2a | 2.9, 7.6 | **<0.01** |
| **Q45: In the last week, I have worried about having enough money to pay the bills or buy food** | 1.6±1.2 | -0.63, 3.9 | 0.16 |

Patients’ answers to QoL questions were treated as continuous variables (1=“totally agree”, 2=“somewhat agree”, 3=“neither agree or disagree”, 4=“somewhat disagree”, 5=“totally disagree”), and DEMQOL-proxy ranged from 31 to 124, with higher scores indicating enhanced patient QoL. aA 1-point increase in the patients’ QoL answer was significantly associated with the following change in DEMQOL-Proxy score: +5.6 for Q39, +5.4 for Q40, +3.3 for Q41, +4.8 for Q42, +4.0 for Q43, and +5.2 for Q44. CI, confidence interval; DEMQOL, Dementia Quality of Life; QoL, quality of life.

**Supplementary Table 7.** Unpaid/informal caregiver QoL and costs by disease severity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **MCI****N=24** | **Mild AD****N=26** | **Moderate AD****N=18** | **Severe AD****N=11** | **Total AD****N=55** |
| **CarerQoL-7D utility score** | 79.8 (8.7) | 73.9 (12.2) | 76.0 (12.8) | 73.9 (14.0) | 74.6 (12.6) |
| **Costs per person per month, $** |  |  |  |  |  |
| **Indirect costs to caregivers** | 1,970.4 (1,970.3) | 1,446.7 (1,465.4) | 2,545.8 (2,516.3) | 2,375.8 (1,194.6) | 1,992.2 (1,878.1) |
| **Costs to employers** | 810.1 (1,928.5) | 1,340.0 (2,280.3) | 1,725.4 (2,431.8) | 774.8 (1,801.5) | 1,353.1 (2,232.6) |
| **Intangible costs to caregivers** | 636.5 (746.1) | 1,223.6 (1,209.9) | 1,116.7 (1,296.0) | 1,294.3 (1,482.3) | 1,202.7 (1,271.9) |

Values are expressed as mean ± standard deviation. AD, Alzheimer’s disease; MCI, mild cognitive impairment.

**Supplementary Table 8.** Parameter estimates and p-values for final models for overall caregiver sample and the subgroup of 79 unpaid/informal caregivers

|  |  |  |
| --- | --- | --- |
|  | **All Caregivers****(n=100)** | **Informal Caregivers****(n=79)** |
| **Parameter** | **Estimate** | ***p*** | **Estimate** | ***p*** |
|  | **CarerQoL-7D utility scores** |
| Intercept | 68.67 | **<0.0001** | 107.36 | **<0.01** |
| Severity | -0.43 | 0.6697 | -14.74 | **0.02** |
| Sex (female versus male) | 20.67 | **0.0416** |  |  |
| Agea  | 0.10 | 0.5928 | -0.48 | 0.07 |
| Employment (employed versus other) | 4.01 | 0.2867 | 4.48 | 0.25 |
| Age\*sex (female) | -0.30 | 0.0754 | 0.22 | **0.03** |
|  | **Indirect costs to caregivers** |
| Intercept | -1048.95 | 0.1936 | -3382.00 | **0.01** |
| Severity | 480.39 | 0.1164 | 208.20 | 0.18 |
| Sex (female versus male) | 330.34 | 0.3526 | 342.25 | 0.32 |
| Marital status (married) | 1304.96 | 0.1384 |  |  |
| Employment (employed versus other) | 1621.45 | **<0.0001** | 3460.91 | **<0.01** |
| Hours providing care | 22.60 | **<0.0001** |  |  |
| Severity\*Marital status (married) | -872.65 | **0.0132** |  |  |
| Age |  |  | 58.25 | **<0.01** |
|  | **Intangible costs to caregivers** |
| Intercept | 2928.95 | 0.1931 | -2232.60 | 0.14 |
| Severity  | -1509.97 | 0.0780 | 1656.78 | **<0.01** |
| Sex (female versus male) | -314.94 | 0.1639 | -381.86 | 0.15 |
| Years of educationb | -140.09 | 0.3109 |  |  |
| Agea | 4.17 | 0.7438 | 51.52 | **0.03** |
| Employment (employed versus other) | -327.62 | 0.3656 |  |  |
| Severity\*Years of education | 108.58 | 0.0633 |  |  |
| Severity\*Age |  |  | -24.27 | **0.02** |

aAge groups were transformed into continuous values by using the center value of each age group. b Educational levels were transformed to years of education.

**Supplementary Table 9.** Derivation steps for costs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **MCI****N=27** | **Mild AD****N=27** | **Moderate AD****N=25** | **Severe AD****N=21** | **Total AD****N=73** |
|  | **Derivation steps for indirect costs to caregivers** |
| Value of lost production time for a working caregiver  | 2,596.6 ± 2,450.1 (n=13) | 3,489.4 ± 2,137.1(n=5) | 2,180.5 ± 2,869.8 (n=16) | 1,077.1 ± 1,904.7 (n=13) | 1,951.1 ± 2,510.3(n=34) |
| Value of lost leisure time for the non-working caregiver  | 966.6 ± 863.5 (n=14) | 916.7 ± 705.9 (n=22) | 1,215.3 ± 1,194.0 (n=9) | 2,230.3 ± 1,037.0 (n=8) | 1,255.1 ± 1,020.0(n=39) |
|  | **Derivation steps for costs to employers** |
| Absenteeism cost  | 76.3 ± 278.0 | 43.1 ± 174.5 | 434.1 ± 1,025.4 | 160.5 ± 674.3 | 207.7 ± 712.8 |
| Replacement cost (caregivers) | 482.8 ± 1,765.4 | 804.7 ± 1,582.6 | 347.6 ± 1,243.3 | 258.6 ± 1,185.3 | 491.1 ± 1,367.4 |
| Replacement cost (patients) | 281.6 ± 883.2 | 442.6 ± 1,322.2 | 478.0 ± 1,257.5 | 310.4 ± 980.3 | 416.7 ± 1,195.9 |
|  | **Derivation steps for intangible costs to patients** |
| Age-adjusted Utility Indexa | 0.818 ± 0.006 | 0.815 ± 0.006 | 0.818 ± 0.006 | 0.817 ± 0.006 | 0.817 ± 0.006 |
| DEMQOL-Proxy Utility score | 0.706 ± 0.110 | 0.665 ± 0.118 | 0.697 ± 0.096 | 0.562 ± 0.107 | 0.646 ± 0.120 |
| Utility reductionb | 0.120 ± 0.098 | 0.157 ± 0.107 | 0.126 ± 0.088 | 0.256 ± 0.108 | 0.175 ± 0.113 |
|  | **Derivation steps for intangible costs to caregivers** |
| Age-adjusted Utility Indexa | 0.833 ± 0.030 | 0.820 ± 0.008 | 0.832 ± 0.020 | 0.834 ± 0.021 | 0.828 ± 0.018 |
| CarerQoL-7D Utility score | 0.808 ± 0.091 | 0.742 ± 0.120 | 0.777 ± 0.128 | 0.789 ± 0.119 | 0.767 ± 0.123 |
| Utility reductionb | 0.049 ± 0.058 | 0.095 ± 0.096 | 0.079 ± 0.100 | 0.061 ± 0.095 | 0.080 ± 0.097 |

AD, Alzheimer’s disease; DEMQOL, Dementia Quality of Life; DS, dependence scale; CarerQoL-7D, Care-related Quality of Life – 7 dimensions; MCI, mild cognitive impairment. a Age-adjusted health utilities of general population. b Assumed 0 for negative difference between population utility index and caregiver's health utility.