Aging Without a Car, Version 1.0: methods and technical appendix

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1. Analysis plan

The analysis follows a statistical analysis plan approved and locked by David P. Faustina of SeniorMedRides.com on 13 November 2026 (Gate 1), before any estimate for this study was run. The plan fixed the data, universe, recodes, eight tables, two test families, reliability tiers, sensitivity checks, lead-finding rule and language rules. No change to the analysis was needed. One publication decision touching plan section 10 (the report page address) is recorded in the package deviations log; it affects no estimate. Nothing outside the plan was run (no race or ethnicity analysis, no earlier-period comparison, no pairwise area tests and no re-test of a Version 1.0 comparison).

2. Data and universe

- **Data:** U.S. Census Bureau, ACS 2020–2024 5-year PUMS, person and housing files for Arizona, California, Florida, Idaho, Nevada and Utah (https://www2.census.gov/programs-surveys/acs/data/pums/2024/5-Year/), the same downloaded files as Version 1.0, verified against the Version 1.0 input checksums.
- **Universe:** people 65 and older whose person record links by SERIALNO to a housing record with TYPEHUGQ = 1 in a study-area 2020 PUMA. Nursing homes and other group quarters are excluded.
- **Study areas:** the eight Version 1.0 study areas, as unions of 2020 PUMAs (`data/study_areas.csv`). Eight-area totals are summed replicate by replicate.
- **Period:** 2020–2024 period averages, not single-year values; they include pandemic-era years.

3. Variables

Variable	Definition	PUMS coding
Age group	65–74, 75–84, 85+	AGEP (top-coded at 99)
Sex	As the ACS item records it	SEX = 1, 2
No household vehicle	No car, van or truck (1 ton or less) kept at home for household use	VEH = 0; any vehicle = VEH 1–6
Living alone	Only person in the household	NP = 1
Serious walking difficulty	ACS ambulatory difficulty item	DPHY = 1; without = 2
Independent living difficulty	Difficulty doing errands alone, such as visiting a doctor's office or shopping	DOUT = 1; without = 2
Poverty band	Below 100%, 100–149%, 150% or more of the official poverty threshold	POVPIP 0–99, 100–149, 150–501
Tenure	**Owner vs renter or occupied without paying rent**	**TEN = 1–2 vs 3–4**

Recode check: household size NP = 1 agrees with household type HHT = 4 or 6 for all 96,130 householders 65+ in the universe (0 disagreements). No values are missing among people 65+ in the universe for walking difficulty, independent living difficulty, poverty ratio or tenure. Variable definitions follow the 2020–2024 PUMS data dictionary (https://www2.census.gov/programs-surveys/acs/tech_docs/pums/data_dict/PUMS_Data_Dictionary_2020-2024.txt).

4. Estimation and variance

- Person weight PWGTP for every estimate, including household-level traits such as no vehicle.
- Shares, differences and ratios are computed from weighted counts inside the full sample and inside each of the 80 replicates (PWGTP1–PWGTP80), never from rounded inputs.
- Standard errors: successive-difference replicate method, SE = $\sqrt{(4/80 \times \Sigma(X_r - X)^2)}$; 90% margins of error, MOE90 = 1.645 × SE (https://www2.census.gov/programs-surveys/acs/tech_docs/pums/accuracy/2020_2024AccuracyPUMS.pdf).
- Direct age standardization inside each replicate to the standard S1, the age mix of all people 65+ in housing units in the eight areas: 65–74 = 0.591331, 75–84 = 0.305893, 85+ = 0.102776. Sensitivity standard S2 (the age mix of people 65+ with serious walking difficulty, from Version 1.0): 0.409652, 0.354223, 0.236126. Age-adjusted figures assume that common age mix; they are summary measures for comparison, not observed shares.
- Area vs the other seven: the other seven areas are pooled replicate by replicate; the difference (area minus pooled rest) is tested with a two-sided z-test, z = difference / SE. Within-area contrasts (family F2) test the age-standardized difference in no-vehicle share, living alone minus not living alone, the same way.
- "About k times" in the lead finding is the ratio rounded to the nearest half, as in Version 1.0.

5. Reliability tiers and suppression

Tier	Rule	How it appears
Reported	n ≥ 50 and CV ≤ 30%	As is
Indicative	n 30–49, or CV above 30% up to 50%	Shown, marked "indicative only; do not quote on its own"
Suppressed	**n under 30, CV above 50%, or a zero sample count**	**Shown as "— (sample too small)"; the value is not published**

n is the unweighted sample count in the numerator; CV is the standard error divided by the estimate. Differences and ratios take the weaker tier of their two component shares and carry the smaller component n and larger component CV. Tiers were assigned in code before any value was read. Age detail by area: if any age cell for a quantity in an area had n under 50, 75–84 and 85+ would be combined as 75+; no area needed this. Table 7 area figures are shown only where n ≥ 50; all eight areas qualify.

Tables with every estimate in the Reported tier: T1, T2, T4, T5, T6, T7, T8. Table 3 cells not in the Reported tier (7):

- Boise PUMA region, no household vehicle, 100–149% of poverty threshold: Indicative (n 49); shown, marked "indicative only; do not quote on its own"
- Boise PUMA region, no household vehicle, of which occupied without payment of rent: Suppressed (n 11); shown as "— (sample too small)"
- Las Vegas, no household vehicle, of which occupied without payment of rent: Suppressed (n 27); shown as "— (sample too small)"
- Orlando, no household vehicle, of which occupied without payment of rent: Suppressed (n 23); shown as "— (sample too small)"
- Sacramento, no household vehicle, of which occupied without payment of rent: Indicative (n 37); shown, marked "indicative only; do not quote on its own"
- Salt Lake City, no household vehicle, of which occupied without payment of rent: Suppressed (n 9); shown as "— (sample too small)"
- Stockton, no household vehicle, of which occupied without payment of rent: Suppressed (n 18); shown as "— (sample too small)"

6. Statistical tests

Two test families, 17 tests in all, each Holm-adjusted at a 10% familywise error rate. Nothing else in the study is tested; Tables 3, 7 and 8 are descriptive. A result that remains after Holm adjustment is described as higher or lower than the other seven combined; all others are "not distinguishable from the other seven combined." A result that remains at 10% but would not at 5% is labeled borderline and kept out of headlines and fact sheets. An area is tested only if every age-specific share in its standardized measure rests on at least 30 sample records in the denominator and 10 in the numerator; all areas qualified for both families. Study areas are never ranked.

F1. Each study area vs the other seven combined: age-standardized share of all people 65+ who live alone in a household with no vehicle (8 tests)

Study area	Difference (points)	z	p	Holm-adjusted p (S1)	Result (S1)	Borderline (S1)	S2 difference (points)	Holm-adjusted p (S2)	Result (S2)	Sensitivity note
Boise PUMA region	-0.99 ±0.43	-3.78	<0.001	<0.001	lower than the other seven combined	no	-1.13	0.063	lower than the other seven combined (borderline: remains at 10% familywise level only)	Under the alternative age standard S2 the result still remains but is borderline: it remains at the 10% familywise level, not at 5% (S2 Holm-adjusted p 0.063).
Las Vegas	+0.53 ±0.32	2.75	0.00595	0.0178	higher than the other seven combined	no	-0.01	1.0	not distinguishable from the other seven combined	Changes under the alternative age standard S2: not distinguishable from the other seven combined (S2 difference -0.01 points; Holm-adjusted p 1.0).
Orlando	-0.52 ±0.38	-2.25	0.0243	0.0486	lower than the other seven combined	no	-1.01	0.0164	lower than the other seven combined	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p 0.0164). Its Holm-adjusted p under the main standard (0.0486) is close to the 0.05 level that marks a borderline result.
Phoenix	-0.67 ±0.26	-4.14	<0.001	<0.001	lower than the other seven combined	no	-0.71	0.0163	lower than the other seven combined	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p 0.0163).
Sacramento	+0.56 ±0.30	3.06	0.00222	0.00889	higher than the other seven combined	no	+1.05	0.00277	higher than the other seven combined	Unchanged under the alternative age standard S2

Study area	Difference (points)	z	p	Holm-adjusted p (S1)	Result (S1)	Borderline (S1)	S2 difference (points)	Holm-adjusted p (S2)	Result (S2)	Sensitivity note
										(S2 Holm-adjusted p 0.00277).
Salt Lake City	-0.03 ±0.48	-0.11	0.909	0.909	not distinguishable from the other seven combined	no	-0.07	1.0	not distinguishable from the other seven combined	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p 1.0).
Stockton	-0.77 ±0.41	-3.14	0.00171	0.00854	lower than the other seven combined	no	-0.88	0.0757	lower than the other seven combined (borderline: remains at 10% familywise level only)	Under the alternative age standard S2 the result still remains but is borderline: it remains at the 10% familywise level, not at 5% (S2 Holm-adjusted p 0.0757).
Tampa	**+0.75 ±0.30**	**4.12**	**<0.001**	**<0.001**	**higher than the other seven combined**	**no**	**+1.13**	**<0.001**	**higher than the other seven combined**	**Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).**

F1: 7 of 8 remain after Holm adjustment under S1; none is borderline under S1. Under S2, the Las Vegas result no longer remains, and the Boise PUMA region and Stockton results remain but are borderline.

F2. Within each study area: age-standardized no-vehicle share, living alone minus not living alone (9 tests)

Study area	Difference (points)	Age-adjusted ratio	Holm-adjusted p (S1)	Result	Sensitivity note
Boise PUMA region	+9.77 ±1.78	6.58 ±2.45	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Las Vegas	+15.15 ±1.16	5.50 ±0.77	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Orlando	+13.46 ±1.49	5.39 ±0.93	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Phoenix	+10.68 ±0.84	4.86 ±0.64	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Sacramento	+13.28 ±1.10	4.91 ±0.71	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Salt Lake City	+13.05 ±2.05	5.50 ±1.41	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Stockton	+10.73 ±1.83	4.26 ±1.02	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Tampa	+12.72 ±0.93	5.37 ±0.59	<0.001	no-vehicle share higher among people living alone than among those living with others	Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).
Eight areas combined	**+12.48 ±0.42**	**5.21 ±0.27**	**<0.001**	**no-vehicle share higher among people living alone than among those living with others**	**Unchanged under the alternative age standard S2 (S2 Holm-adjusted p <0.001).**

F2: 9 of 9 remain after Holm adjustment under both standards; none is borderline.

7. Reporting rules for headlines and fact sheets

- **Headlines** use only the lead finding pre-specified in the analysis plan (section 8 below). No study-area comparison appears in a headline, title, page description or announcement.
- **Sensitive study-area comparisons.** Set by David P. Faustina on 14 November 2026, after the results were produced and before drafting: an F1 result that changes or becomes borderline under the alternative age standard S2, or whose Holm-adjusted p under S1 is within 0.01 of the 0.05 borderline level (0.04 to 0.05), is reported in the tables and this appendix with its sensitivity note, but is not used in headlines, summaries or fact sheets. This applies to the Boise PUMA region (borderline under S2), Las Vegas (not distinguishable under S2), Orlando (Holm-adjusted p 0.0486 under S1) and Stockton (borderline under S2).
- **Fact sheets** state the F1 result for Phoenix (lower than the other seven combined), Sacramento (higher than the other seven combined), Tampa (higher than the other seven combined). The Salt Lake City fact sheet makes no comparison claim.

- The rule limits where results are summarized; it does not remove any result from the tables, data files or this appendix. No estimate, test or tier changed.

8. Lead finding (rule set in the analysis plan)

The plan fixed the lead template and fallback order before any estimate was run. Rule 1: the eight-area count of people 65+ living alone with no vehicle (Table 4) is used only if its CV is 10% or less; it is (CV 0.0167). Rule 2: the eight-area living-alone contrast (family F2) is used only if it remains after Holm adjustment and is not borderline; it does. "About k times" rounds the unadjusted and age-adjusted ratios (5.81 and 5.21) to the nearest half.

> An estimated 112,207 people 65 and older in eight U.S. study areas live alone in a household with no vehicle. Among older adults without a vehicle, 65.1% live alone. People 65 and older who live alone are about 6 times as likely to have no household vehicle as those who live with others, about 5 times after adjusting for age.
>
> These estimates do not directly measure missed medical appointments, transportation demand, wheelchair use, or unmet transportation needs. Independent living difficulty is a self-reported difficulty doing errands alone, such as visiting a doctor's office or shopping; it is not a record of missed appointments.

9. Sensitivity checks

1. **Poverty cut:** Table 3 rerun with below 150% of poverty in place of below 100% (`data/sensitivity_poverty_cut_150.csv`). Descriptive; no conclusion can change.
2. **Age standard:** F1 and F2 rerun with S2 (`data/sensitivity_age_standard_s2.csv`). Results whose conclusion or borderline status changes are noted beside each result in the report and above.

10. Checks and validation

- Version 1.0 reproduction: the reused figures (Tables 1 and 2, and the Version 1.0 walking-difficulty contrast) were reproduced exactly from the same Census files, margins of error included, and the Version 1.0 code was rerun with byte-identical outputs.
- Internal sums: age groups sum to area totals, areas to the eight-area total, and living alone plus not living alone to all people 65+, replicate by replicate; Table 3 shares sum to 100% within rounding.
- An extended Version 1.0 consistency checker (language rules, reliability tiers, test wording, lead rule) and a planted-error self-test were run on the analysis outputs; the publication files were checked again for this package (number trace, language, suppression, reporting rules, web metadata).
- Validation: Dee C. independently rebuilt the analysis from the raw Census files; all 3,303 output cells matched exactly (PASS WITH NOTES, accepted by David P. Faustina, 14 November 2026). Runs v1.1 and v1.2 changed only code, checks and documentation, adding sample-count and reporting-status columns; all 10,179 output values are identical to the validated run.

11. Reused Version 1.0 figures

Tables 1 and 2 (people 65+ in a household with no vehicle, by area and by age) are reused from SeniorMedRides.com. (2026). *Senior Transportation Access Report: Walking Difficulty and Household Vehicle Access Among Older Adults in Eight U.S. Study Areas* (Version 1.0). https://seniormedrides.com/research/senior-transportation-access/ https://doi.org/10.5281/zenodo.24210261 They are cited as published and were never re-estimated into a second value. Version 1.0 area comparisons of the no-vehicle share are cited there and not re-tested.

12. Disclosures that travel with any use of these results

- These estimates do not directly measure missed medical appointments, transportation demand, wheelchair use, or unmet transportation needs.
- Independent living difficulty is a self-reported difficulty doing errands alone, such as visiting a doctor's office or shopping; it is not a record of missed appointments.
- Living alone is measured from the household roster; the survey does not record whether relatives or friends live nearby or help with rides.
- Differences between groups are associations, not causes.
- Study-area figures describe each area as a whole, not individuals or places outside the study-area definitions.
- Source data: U.S. Census Bureau, American Community Survey (ACS) 2020–2024 5-year Public Use Microdata Sample (PUMS). The Census Bureau has not reviewed, endorsed or certified this analysis or its findings.

13. Software and reproducibility

Python standard library; the Version 1.0 estimation code with new tables added (analysis code version awac-run-1.2.0). Analysis run package SHA-256 3f073624fe387e8ab6fc29cb31274be882bf8e764dd35b349338f0aa8681c4c0. Original research code: MIT License approved in principle; to be distributed separately after ownership and dependency review (pending).

14. Version and corrections

Version 1.0. Publication date: November 17, 2026. Corrections will be logged with dates and before/after values.

15. License and how to cite

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> SeniorMedRides.com. (2026). *Aging Without a Car: Living Alone and Household Vehicle Availability Among Older Adults in Eight U.S. Study Areas* (Version 1.0). https://seniormedrides.com/research/aging-without-a-car/ https://doi.org/10.5281/zenodo.24235541

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