

Online Supplementary Appendix

“Evaluating the Impact of Safe Patient Handling and Movement Laws on Nursing Home Worker Injuries”

Summary of contents

The supplementary content provides further information on the rationale for selecting the OSHA Data Initiative (ODIA) data for the present analysis, the matching process of three data sources used, comparison of nursing home characteristics to address concerns regarding selection bias, further technical details regarding the multiple imputation procedures, further information to address concerns regarding confounding, and a series of sensitivity analyses to demonstrate the robustness of the primary findings reported in the main text.

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APPENDIX 1 DATA SOURCES

We considered several potential sources of data for tabulating worker injuries in the nursing home setting. Supplementary Table 1 below shows the alternative data sources considered. Each of the data sources described has strong reasons for consideration, from the individual-level worker data available in state Workers Compensation Systems and the fatal incident reports, to the extensive temporal coverage and methodologic consistency of the Bureau of Labor Statistics annual reports. The primary reasons for excluding these data sources were: 1) lack of data at the nursing home level; and 2) lack of data across the entire time frame of interest, including several years before and after the period in which SPHM legislation was enacted.

We selected the Occupational Safety and Health Administration's Data Initiative (ODI) for this analysis. The OSHA Data Initiative includes information on the overall rate of work-related injuries and illnesses reported by a wide range of establishments (workplaces) in the United States and her territories, from 1996 to 2011. We obtained these files from OSHA at: https://www.osha.gov/pls/odi/establishment_search.html as files covering the periods 1996 to 2011, 2002-2006, and annual files from 2007 to 2011. The dataset includes several fields reported by the establishment, including the establishment's name and address, the industrial classification code the establishment feels is the best fit, and three work-related injury and illness rates, all denominated per 100 Full-Time Equivalent (FTE's). These are 1) the Total Case Rate (TCR), the total number of reported work-related injuries and illnesses per 100 FTE's, regardless of severity; 2) the DART rate (work-related injuries and illnesses resulting in Days Away from work, Restriction of job activities, and/or Transfer to another position), per 100 FTE's, and 3) the DAFWII rate (Injuries and Illnesses resulting in Days Away From Work), per 100 FTE's. Unfortunately, the publicly available ODI data includes these rates only, and neither the injury and illness count numerator, nor the sum of FTE's (the denominators). Thus,

implausible changes in rates are difficult to identify by comparing across years (e.g. a ten-fold increase in the reported injury rate from 2 per 100 FTE's to 20 per 100 FTE's would be more plausible if the FTE denominator remains relatively stable, much less plausible if the FTE denominator were nearly one tenth the size it was in previous and subsequent years)

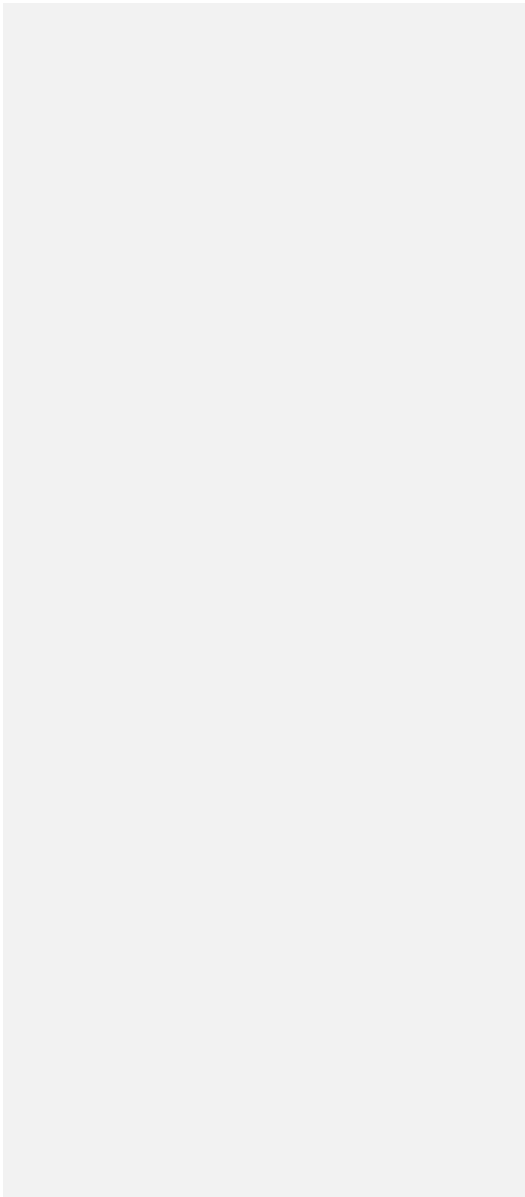
In general, government-operated establishments were exempt from reporting ODI data, and several states received waivers from reporting requirements for periods of time ranging from a single year to the entire ODI reporting period. As described in the main text, we excluded data from states that were waived from reporting requirements for two or more consecutive years during our study period (2002 to 2010). Among potentially eligible establishments, the ODI sampling strategy was stratified such that establishments in industrial sectors with a high average work-related injury and illness rate (such as nursing homes) were sampled every three years, on a rotating basis. Additionally, establishments reporting a high DART rate (5 per 100 FTE's and higher) were generally required to report again the following year. Thus, ODI data are not complete across all years for nursing homes, and the missing data is far from randomly distributed. However, because the reasons for missing data are fairly well understood, imputation techniques were employed to recover close approximations of the underlying data distribution.

In summary, the ODI's major strengths include reporting at the establishment level, over an extended period of time. Reasons for concern include the fact that ODI reporting stopped after 2011, the unusual sampling strategy employed in ODI, and the lack of reported denominator data to estimate the number of affected workers. Because of the non-random nature of the sampling in ODI, we characterized the structured nature of the missing data in this source, and to use multiple imputation techniques to recover a plausible version of the original data distribution.

Supplementary Table 1. Alternative data sources and rationale for exclusion

Data Source	Level of data Time frame	Available Metric	Rationale for exclusion
Bureau of Labor Statistics Annual Reports ¹	State 1996 to present	Average work-related injury and illness counts and rates within industrial sectors	<p>1. For many states in many years, nursing homes are not an identifiable reporting unit.</p> <p>2. The industrial classification coding system shifted in 2007 from the SIC (Standard Industrial Classification) system to the NAICS (North American Industrial Classification System). The discontinuity in reporting practices coincides with 2007 -the last year in which states enacted SPHM legislation.</p> <p>3. The reporting unit is state level and we needed nursing home level data.</p>
Fatal Incident Reports ²	Nursing home sector 1992-present	Fatalities	<p>1. Events are too infrequent to permit meaningful analyses.</p> <p>2. The reporting unit is at the nursing home sector level and we needed nursing home level data.</p> <p>3. Fatal injury data identifiable to the individual worker, including specific workplace is available for 2009-2017, which does not provide information in the years before legislation enactment.³</p>
Severe Injury Reports ⁴	No denominator 2015-present	Severe injuries (e.g., fatalities, hospitalizations, amputations, loss of eye)	<p>1. No data available in the years before legislation enactment.</p> <p>2. No denominator to describe the populations from which the events arose.</p>

Worker Compensation Claims	State Worker level	Injury claims	1. Obstacles to sharing individual-level data outside of state agencies where the data are collected and maintained proved insurmountable.
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APPENDIX 2 - MATCHING DATA

The analysis required combining information from three datasets with information about nursing homes: 1) Provider of Service (POS) files; 2) Minimum Data Set 2.0 Resident Assessment Instrument (MDS) Files; and 3) Occupational Safety and Health Administration Data Initiative (ODI) Files. Although these datasets contain complementary subject matter, they span different time periods, and have different approaches to identifying the same nursing homes over time. A summary of the nursing home data sources, years available, matching information, and key variables is provided in Supplementary Table 2 below. We matched establishments in these data sources by hand on the basis of a shared name and address to the POS provider numbers described in because there was no standardization in name or address reporting in ODI.

Of 137,998 potential establishment-years identified using these industrial codes, we matched 120,243 (87.1%) to a POS provider number. These unmatched establishments appear to overwhelmingly belong to the additional classes of health care establishment covered by these industrial classification codes, but a small number could not be matched due to vague name and address information. Following this first pass, we then searched for establishments with the same address as reported in the POS files, but not self-identified using one of the industrial codes above. This yielded 500 additional matches across the 16 year period, for a total of 120,743 establishment-years of ODI data matched to an identifiable nursing home provider number. We found 2,876 records for 1,429 establishment-years with more than one record in a given year. We used a two-step process to select one record to represent each establishment-year uniquely. First, we generated a weighted count of missing or implausible injury and illness rates reported for each record, then among the record(s) with the least amount of missing information, we selected one at random. Each ODI record has up to three work-related injury and illness rates reported: the Total Case Rate (TCR), the DART (injuries and

illnesses resulting in Days Away from work, Restriction of job activities, or Transfer to another position), and the DAFWII (Days Away From Work due to Injuries and Illnesses). Since we used only the DART rate in our analyses, we weighted missing DART data three times higher than missing TCR or DAFWII data. Following procedures laid out by prior authors (citations 21-23 from the main text), we also considered a TCR above 100 per 100 Full-Time Equivalents (FTE's), a DART rate above 50 per 100 FTE's, or a DAFWII above 50 per 100 FTE's to be "missing" data, as these values are implausibly high.

Supplementary Table 2. Nursing home data sources matched for the analysis

Data Source	Level of data Time frame Frequency of updates	Matching variables	Variables
Provider of Service (POS) Files ⁵	Nursing home 1984 to present Annual files through 2005, quarterly updates thereafter	Nursing home address Nursing home identifier (prov1680)	profit orientation and ownership, hospital affiliation, and staffing
Minimum Data Set 2.0 Resident Assessment Instrument (MDS) Files (obtained through Data Use Agreement)	Nursing home resident 1/1/2002 to 10/31/2010	The nursing home identifier on these files is directly linkable to the POS files in each year.	Quarterly aggregates of variables listed in Supplementary Table 4 were calculated and then averaged to obtain annual descriptors of resident characteristics.
Occupational Safety and Health Administration Data Initiative (ODI) Files ⁶	Nursing home 1996 to 2011, 2002-2006, 2007 to 2011	Nursing home name Address Industrial sector ⁷	DART rate (work-related injuries and illnesses resulting in Days Away from work, Restriction of job activities, and/or Transfer to another position) per 100 FTEs

⁵ In the great majority of cases, this provider number allows identification of the same nursing home across multiple years of operation. There are a small number of nursing homes that change provider numbers over time, for a variety of reasons, including a change in ownership, expanding into or moving to a new building, or change in type of certification (e.g. from "nursing facility" to "dually certified SNF/NF"). In some cases, state administrators decided to re-number a substantial number of providers in their jurisdiction for administrative convenience. Therefore, for each year, we examined all "new" provider numbers to assess whether they matched a previous nursing home according to other characteristics: name (prov0475), address (prov2720, prov3225,

prov3230, prov2905), and type of certification (prov0075, prov0085), and created a new provider number to uniquely identify each nursing homes across all years.

From 1996 through 2007, we used the following industrial sector codes: Standard Industrial Classification: 8051="Services-skilled nursing care facilities"; 8052="Intermediate care facilities"; 8059="Nursing and personal care facilities, not elsewhere classified" and from 2007-2011, we used the following North American Industry Classification System code: 623110="Nursing care facilities (skilled nursing facilities)" to identify potential nursing homes in ODI (137,998 establishment-years). We matched 120,243 (87.1%) of these from ODI to POS by hand on the basis of names and addresses, and then POS to ODI by address to identify nursing homes not listed using the SIC or NAICS codes above (500 nursing-home years).

APPENDIX 3 - IMPUTATION

Overview.

We used a multiple imputation model to reduce bias originating in missing data in our outcome variable. Imputation of outcome data usually produces less biased results than complete case analysis when missingness of the outcome can be predicted from covariates.⁷ Below, we describe the motivation for using a multiple imputation model, detailed methods for implementing the imputation model (including the rationale for selecting 50 replicates), the method for combining replicate analyses into a single summary,⁸ and a comparison of our main findings to two analyses using alternate approaches to handling missing outcome data (complete case and single imputation). We followed Johnson and Young's recommendations⁹ for designing the imputation model, and reporting sufficient detail in its construction for readers to be able to evaluate the method.

Motivation for the Imputation Model: Missing Data in the ODI.

Workplaces (establishments) were not required to report work-related injury and illness data to ODI in all years. Nursing homes are in an industrial sector that is usually required to report every three years. In addition, nursing homes reporting a high rate of work-related injuries and illnesses were usually required to report again in the subsequent year. Thus, the pattern of missing data for this key outcome variable was not missing completely at random (MCAR). Among nursing homes with an observed DART rate under 5.00 per 100 FTE's, 51.1% had missing data the following year, while only 13.9% of those with an observed DART rate of 5.00 per 100 FTE's or higher did.

In our dataset of 7,936 nursing homes, 7,423 (93.6%) had DART data reported for at least 5 of the 9 study years. Only 882 had DART data reported in all 9 years, and 11 (0.1%) had

DART data reported in only 2 study years. Supplementary Table 5 shows the degree to which nursing home characteristics and resident aggregate characteristics are associated with missing ODI data. For instance, during the pre-enactment period DART rates were missing for only 7.1% of nursing home-year observations, while 38.3% were missing during the post-enactment period. This does not represent a change in sampling strategy – rather, it represents less frequent year after year sampling as the DART rate in nursing homes declined to under 5.00 for most nursing homes over this period. Across strata of bed sizes, nurse:bed ratios, staffing ratios, profit orientation, chain membership, and urbanicity, the proportion of missing ODI data ranged over a more limited range than the temporal shift described above. When considering resident aggregate characteristics, the proportion of missing ODI observations also varies within narrow ranges. Systematic shifts can be seen with regard to a number of aggregated resident characteristics, for instance nursing homes with higher mean resident weights were more likely to have missing ODI observations (19.5% of nursing home-year in the lowest quartile of mean resident weight, 32.2% of nursing-home years in the highest quartile of mean resident weight). However, for most of these resident aggregate characteristics, these shifts can be readily explained by secular trends in those characteristics. For example, resident weights increased rapidly over the study period. Thus, the observations associated with heavier residents took place during a period of less frequent sampling. Supplementary Table 5 also shows the findings from a multivariable logistic model predicting missing DART rate observations. After simultaneous adjustment for other factors listed in Supplementary Table 5, several characteristics stand out as predictors of missing ODI observations. Notably, observations in the enactment and post-enactment periods were much more likely to be missing, as were nursing homes with smaller bed sizes, lower nurse:bed ratios, a for-profit orientation, a lower proportion of residents dependent in activities of daily living, and a lower proportion of residents requiring mechanical lifting.

Development and implementation of imputation model.

We imputed missing DART values for 50 replicate datasets, using SAS `proc mi`. A “rule of thumb” for selecting the number of imputations is guided by Rubin’s¹⁰ estimation of imputation efficiency, $1/(1+\gamma/m)$, where γ is the proportion of missing observations, and m is the number of imputations. Thus, the estimated efficiency for our dataset with 26% missing DART observations would be 99.5%. Or, taking the year 2010 in which the frequency of un-reported DART data as 50.5%, the efficiency from 50 imputations would be 99.0%. These may well over-estimate the imputation efficiency, given the likelihood of dependence between missing observations, and any deviations from a perfectly missing at random (MAR) imputation model. However, in light of the fact that a higher number of imputed dataset replicates generally reduces bias,¹¹ and in the absence of constraints on computation time, we elected to use a fairly large number of imputations.

Our imputation model included all the nursing home level and resident aggregate factors listed in Supplementary Table 5, and all ODI-reported DART values, including values outside our study window from 1996-2001, and 2011. We included values not included in our analysis because the goal of the imputation model is to produce a range of plausible values for missing data with minimal bias, while maintaining the appropriate level of uncertainty. Given these goals, and despite the fact that these variables are themselves not infrequently missing, DART values reported in ODI but not included in our final analysis, provide valuable information to produce less biased and more precise estimates of the plausible range within which missing values fall, closer to the MAR assumption inherent to multiple imputation techniques.¹² We placed an upper cap on imputations of a DART rate of 100, relaxed to be twice as high as the level considered plausible in previous reports.^{13,14,15} Initially, we attempted to run an imputation model including all time-varying covariates, but found that the imputation model was unable to produce plausible DART rates despite thousands of attempts, presumably due to multi-collinearity issues.

Geographic variables were not time varying (`region`, `Urb_2006_2002`, `ssamsasz_2002`), but for time-varying variables, we maximized the amount of time-varying information we could include, while also producing an imputation model that produced plausible imputations. We used values from the beginning of the study period for profit orientation (`ownership_2001`) and from the beginning and end of the study period for chain membership (`multi_fac_2002`, `multi_fac_2010`), and `provider_category` (a variable that indicates whether the nursing home is registered with CMS as a nursing home alone, or as both a nursing home and a skilled nursing facility). We included an average across all nine years for remaining nursing home level variables from the POS files (`avg_beds`, `avg_staff`), and for all the resident aggregate characteristics. When the model still would not produce plausible imputations, we removed the percent of residents who were White, not Hispanic, as this was highly collinear with the four racial/ethnic makeup variables also included, and replaced state with Medicare region (10 regions, each with several neighboring states).

Because this model includes several categorical variables, an imputation based on the multivariate normal distribution was not possible, so we used a fully conditional specification (FCS) approach (also known as a multivariate imputation by chained equations (MICE) approach, or a “sequential regression” approach). The FCS approach imputes each missing variable in the order specified, then uses imputed and known values from the entire dataset to iterate a second pass through the dataset, repeatedly iterating for some number of “burn-in” imputations before saving an instance as an imputation value. We elected to use a relatively high number of 100 “burn-in” imputations, because the number of nursing homes in this dataset posed no intolerable constraints on computation time.

We imputed the natural logarithm of the DART rates, for three reasons. First, our analytic model was a Poisson model, so the covariance structure for DART rates that the imputations are designed to approximate would be a better fit in that model. Second, a

“negative” DART rate is physically impossible; there is a hard cap at 0 work-related injuries and illnesses in any establishment in a given year. Third, the distribution of reported DART rates, upon visual inspection, appears closer to a Poisson distribution than a normal one. However, since $\ln(0)$ is undefined, we replaced DART rates of 0 with $\ln(0.5)$ for the imputation process.

The following SAS code describes the imputation model, which draws on a “flat” file of 7,936 nursing homes with 16 annual $\ln(\text{DART rates})$ capped at $\ln(100)$, and an expansive list of covariates as described above. The resulting file was then transposed to a “long” format and merged with time-varying covariates for the analytic modeling exercises, and imputed DART rates were obtained by exponentiating the $\ln(\text{DART rate})$ s. Imputed $\ln(\text{DART rate})$ s below 0.5 were re-coded to a DART rate of 0, to mirror the recoding of zero DART rates above.

```
proc mi data=SPHML_flat out=outmi nimpute=50 seed=42
max = . . . . /* geography */
. . . . . /* ownership, chain membership */
. . . . . /* beds, staff */
. . . . . /* age, weight */
. . . . . /* ADLs, resists care, conflict with staff */
. . . . . /* loss of leg function, manual lift, mechanical lift */
. . . . . /* fall or fracture, dementia or Alzheimers, depression */
. . . . . /* pressure ulcers, restraints, antipsychotics */
. . . . . /* Native Americans, Asians, Blacks, Hispanics */
4.60517 4.60517 4.60517 4.60517 4.60517 4.60517 /* cap DART imputations at ln(100) */
4.60517 4.60517 4.60517 4.60517 4.60517 4.60517 4.60517 4.60517 4.60517 4.60517;
class region Urb_2006_2002 ssamsasz_2002 provider_category_2002 provider_category_2010
ownership_2001 multi_fac_2002 multi_fac_2010 ;
FCS nbiter=100 ;
var region urb_2006_2002 ssamsasz_2002
provider_category_2002 provider_category_2010 ownership_2001 multi_fac_2002 multi_fac_2010
avg_beds avg_staff
avg_mean_age avg_mean_kg
avg_pct_dependent avg_pct_resists avg_pct_conflict
avg_pct_loss_leg avg_pct_manual_lift avg_pct_mechan_lift
avg_pct_fall avg_pct_dementia avg_pct_bipolar
avg_pct_HGPU avg_pct_restrained avg_pct_antipsyx
avg_pct_race_natam avg_pct_race_asian avg_pct_race_black avg_pct_race_hispa
ln_DART_1996 ln_DART_1997 ln_DART_1998 ln_DART_1999 ln_DART_2000 ln_DART_2001 ln_DART_2011
ln_DART_2002 ln_DART_2003 ln_DART_2004 ln_DART_2005 ln_DART_2006 ln_DART_2007 ln_DART_2008
ln_DART_2009 ln_DART_2010;
where valid_hybrid_DART_years=9;
run;
```

Method for combining replicate analyses into a single summary:

We used the standard approach described in Rubin's 1987 book for combining the 50 replicate analyses into a single summary. For means and percentiles (as in Table 2 of the main text), this is a simple mean of the 50 replicate analyses, specifically:

$$Q = \sum_{i=1}^m Q_i / m \quad (1)$$

Where Q is the summarized parameter of interest, and Q_i are the parameter estimates from the m replicate analyses, indexed by i . For the difference-in-difference ratio estimates shown in Table 3 of the main text, the untransformed beta coefficients from the 50 replicate analyses are averaged as in (1), then exponentiated to obtain a point estimate.

The variance around this point estimate was then estimated from combining a within-imputation variance, U , and a between-imputation variance, B , where U is again, a simple average of the variances from each of the 50 replicate analyses, U_i .

$$U = \sum_{i=1}^m U_i / m \quad (2)$$

And B is estimated from the dispersion between the summarized parameter of interest, Q , and the individual estimates, Q_i , from each of the m replicate analyses as follows:

$$B = \sum_{i=1}^m (Q - Q_i)^2 / (m - 1) \quad (3)$$

The total variance, T , is summed as:

$$T = U + \left(1 + \frac{1}{m}\right) B \quad (4)$$

Thus, the point estimates and 95% confidence limits for the difference-in-difference ratio estimates are calculated as $\exp(Q)$, $\exp(Q - 1.96 \cdot \sqrt{T})$, and $\exp(Q + 1.96 \cdot \sqrt{T})$, respectively.

Supplementary Table 3 Distribution of Nursing Home Structural and Staffing Characteristics in 2002 among Otherwise Eligible Nursing Homes and those with Sufficient ODI[†] Data

	Potentially Eligible Nursing Homes [†] (n=11,491)	Nursing Homes Matched to MDS [‡] Data (n=11,425)	Nursing Homes with Matched [§] ODI Data (n=7,935)
Bed size			
Under 100 beds	43.9%	43.8%	40.9%
100-299 beds	54.7%	54.8%	57.6%
300+ beds	1.4%	1.4%	1.5%
Nurse:bed ratio			
0.05 to 0.50	28.3%	28.3%	26.5%
0.50 to 0.70	51.7%	51.8%	53.6%
0.70 to 2.51	20.0%	20.0%	19.9%
Ratio of registered nurses to other nursing staff			
0.01 to 0.15	40.4%	40.4%	39.8%
0.15 to 0.25	38.6%	38.6%	39.3%
0.25 to 2.59	21.0%	21.0%	20.9%
For profit	74.6%	74.6%	74.6%
Member of a chain	57.7%	57.8%	56.8%
Urbanicity			
Central county, large metropolitan area (1M+)	21.6%	21.6%	19.3%
Fringe county, large metropolitan area (1M+)	19.9%	19.9%	19.7%
Medium metropolitan area (250,000-999,999)	19.1%	19.1%	19.5%
Small metropolitan area (100,000-249,999)	10.2%	10.2%	10.7%
Micropolitan area (50,000-99,999)	15.3%	15.3%	16.0%
Rural counties	13.9%	14.0%	14.9%

Commenté [SC1]: Maybe add a note that these are the data that we eventually used in the analysis.

[†] ODI: Occupational Safety and Health Administration Data Initiative.

[‡] "Potentially eligible nursing homes" are those which, according to the Provider of Service files were open throughout 2002-2010, operated in the private sector, and not hospital-affiliated.

[§] MDS: Minimum Data Set 2.0, 1/1/2002-10/31/2010. Nursing homes with data from ≥ 9 residents in all 9 study years.

[¶] Sufficient ODI data means the nursing home was linked to ODI data in at least one year from 2000-2004, at least one year from 2008-2011, and no more than 5 consecutive years of unmatched years between 2002-2010.

[¶] Unweighted column percents of nursing homes.

[¶] Quartile boundaries rounded to the nearest whole percentage, among included nursing homes, weighted by size of staff.

Supplementary Table 4 Distribution of aggregated resident characteristics in 2002 among Otherwise Eligible Nursing Homes and those with Sufficient ODI[†] Data

	Potentially Eligible Nursing Homes [†] (n=11,491)	Nursing Homes Matched to MDS [‡] Data (n=11,425)	Nursing Homes with Matched [§] ODI Data (n=7,935)
Aggregated resident characteristics, categorized into quartiles [†]			
Mean resident weight			
38.9 to 66.9 kg	-	52.9%	52.0%
67 to 69.9 kg	-	26.9%	27.8%
70 to 72.9 kg	-	12.4%	13.2%
73 to 179.8 kg	-	7.5%	7.1%
Mean resident age			
32.5 to 77.9 years	-	19.2%	17.9%
78 to 80.9 years	-	21.0%	21.0%
81 to 83.9 years	-	31.6%	32.9%
84 to 94.7 years	-	28.2%	28.2%
Proportion dependent in activities of daily living			
0% to 64.9%	-	38.2%	37.1%
65% to 73.9%	-	27.8%	28.3%
74% to 81.9%	-	20.6%	21.2%
82% to 100%	-	13.4%	13.4%
Proportion who resist care and are not easily modified			
0% to 4.9%	-	17.8%	16.8%
5% to 9.9%	-	25.5%	25.1%
10% to 15.9%	-	24.4%	24.7%
16% to 99.3%	-	32.3%	33.4%
Proportion with conflicted relationships with staff			
0%	-	14.7%	13.6%
0.1% to 0.9%	-	20.7%	20.9%
1.0% to 2.9%	-	29.6%	30.3%
3.0% to 88.3%	-	35.0%	35.2%

Supplementary Table 4 (continued) Distribution of aggregated resident characteristics in 2002 among Otherwise Eligible Nursing Homes and those with Sufficient ODI[†] Data

	Potentially Eligible Nursing Homes [†] (n=11,491)	Nursing Homes Matched to MDS [‡] Data (n=11,425)	Nursing Homes with Matched [§] ODI Data (n=7,935)
Proportion with loss of use of one or both legs			
0% to 19.9%	-	18.6%	18.4%
20% to 27.9%	-	21.1%	21.0%
28% to 36.9%	-	25.1%	25.7%
37% to 100%	-	35.3%	34.9%
Proportion who require mechanical lifting			
0% to 5.9%	-	41.1%	38.0%
6% to 11.9%	-	25.9%	26.6%
12% to 18.9%	-	17.7%	20.8%
19% to 96.9%	-	15.2%	14.6%
Proportion who have fallen in the last 30 days and/or had a hip fracture in the last 180 days			
0% to 14.9%	-	26.7%	25.2%
15% to 19.9%	-	28.1%	28.6%
20% to 24.9%	-	25.8%	27.4%
25% to 60.7%	-	19.4%	18.7%
Proportion with dementia and/or Alzheimer's			
0% to 39.9%	-	29.1%	27.5%
40% to 49.9%	-	28.9%	29.0%
50% to 57.9%	-	21.6%	22.2%
58% to 100%	-	20.5%	17.8%
Proportion with bipolar depression			
0% to 0.9%	-	29.8%	28.6%
1% to 1.9%	-	16.8%	17.3%
2% to 4.9%	-	28.5%	29.7%
5% to 100%	-	25.0%	24.4%
Proportion with high grade (2-4) pressure ulcers			
0% to 5.9%	-	27.2%	27.2%
6% to 8.9%	-	28.6%	29.1%
9% to 11.9%	-	23.6%	23.9%
12% to 53.5%	-	20.6%	19.9%

Supplementary Table 4 (continued) Distribution of aggregated resident characteristics in 2002 among Otherwise Eligible Nursing Homes and those with Sufficient ODI[†] Data

	Potentially Eligible Nursing Homes [†] (n=11,491)	Nursing Homes Matched to MDS [‡] Data (n=11,425)	Nursing Homes with Matched [§] ODI Data (n=7,935)
Proportion restrained			
0% to 1.9%	-	9.3%	9.1%
2% to 5.9%	-	12.6%	13.3%
6% to 17.9%	-	24.4%	25.5%
18% to 100%	-	53.7%	52.1%
Proportion who have taken antipsychotics in the last week			
0% to 15.9%	-	22.7%	22.2%
16% to 21.9%	-	26.9%	27.4%
22% to 28.9%	-	25.1%	25.6%
29% to 100%	-	25.3%	24.8%
Proportion of residents who are Asian			
0%	-	66.0%	67.3%
0.1% to 0.9%	-	18.5%	18.9%
1.0% to 1.9%	-	6.9%	6.7%
2.0% to 100%	-	8.7%	7.1%
Proportion of residents who are Black			
0%	-	27.2%	28.0%
0.1% to 2.9%	-	25.9%	26.5%
3% to 12.9%	-	24.6%	24.4%
13% to 100%	-	22.2%	21.1%
Proportion of residents who are Hispanic			
0%	-	47.9%	49.6%
0.1% to 0.9%	-	17.7%	18.3%
1.0% to 2.9%	-	14.8%	15.0%
3.0% to 100%	-	19.6%	17.1%

[†] ODI: Occupational Safety and Health Administration Data Initiative.

[‡] "Potentially eligible nursing homes" are those were open throughout 2002-2010 (per POS), operated in the private sector, and not hospital-affiliated.

[‡] MDS: Minimum Data Set 2.0, 1/1/2002-10/31/2010. Nursing homes with data from ≥9 residents in all 9 study years.

[§] Sufficient ODI data means the nursing home was linked to ODI data in at least one year from 2000-2004, at least one year from 2008-2011, and no more than 5 consecutive years of unmatched years between 2002-2010.

[¶] Unweighted column percents of nursing homes.

[‡] Quartile boundaries rounded to the nearest whole percentage, among included nursing homes, weighted by size of staff.

Supplementary Table 5. Distribution of Missing Work-Related Injury and Illness (DART) Rates, Predictors of Missing Data, and Distributions of Observed and Imputed Values

	Nursing Home-Years with Missing Data	Adjusted PR [‡] (95% CI)	Distribution of DART Rates among Observed Values	Distribution of DART Rates among Imputed Values
	% [†]		Median [†] (25 th , 75 th Percentile)	Median [†] (25 th , 75 th Percentile)
Total	25.6%		6.58 (3.64, 10.30)	3.89 (2.07, 7.17)
Calendar year				
Pre-enactment period (2002-2003)	7.1%	(ref)	7.22 (3.90, 11.30)	5.55 (2.85, 10.58)
Enactment period (2004-2007)	25.3%	3.53 (3.34–3.73)	6.76 (3.81, 10.41)	3.71 (1.98, 6.83)
Post-enactment period (2008-2010)	38.3%	5.54 (5.22–5.89)	5.78 (3.19, 9.11)	3.89 (2.09, 7.10)
Bed size				
Under 100 beds	26.9%	(ref)	6.11 (2.92, 10.28)	3.48 (1.82, 6.54)
100-299 beds	25.2%	0.51 (0.49–0.53)	6.77 (3.91, 10.38)	4.06 (2.18, 7.43)
300+ beds	24.0%	0.19 (0.17–0.21)	6.17 (3.53, 9.25)	3.89 (2.18, 6.99)
Nurse:bed ratio				
0.05 to 0.50	27.8%	(ref)	5.59 (2.57, 9.53)	3.35 (1.73, 6.37)
0.50 to 0.70	24.8%	0.70 (0.67–0.73)	6.72 (3.72, 10.47)	3.92 (2.10, 7.22)
0.70 to 2.51	25.8%	0.57 (0.54–0.59)	6.81 (4.09, 10.35)	4.16 (2.27, 7.52)
Ratio of registered nurses to other nursing staff				
0.01 to 0.15	27.3%	(ref)	6.12 (3.15, 9.81)	3.57 (1.90, 6.63)
0.15 to 0.25	24.2%	0.94 (0.91–0.97)	6.97 (4.02, 10.65)	4.16 (2.24, 7.58)
0.25 to 2.59	25.1%	0.96 (0.92–1.00)	6.71 (3.77, 10.48)	4.13 (2.21, 7.54)
Profit orientation				
For profit	26.6%	1.17 (1.12–1.21)	6.39 (3.40, 10.20)	3.75 (1.98, 6.96)
Non-profit	23.2%	(ref)	7.02 (4.18, 10.48)	4.30 (2.36, 7.76)
Chain membership				
Member of a chain	25.2%	1.05 (1.02–1.09)	7.16 (4.08, 10.92)	4.19 (2.25, 7.69)
Not a member of a chain	26.1%	(ref)	6.00 (3.20, 9.52)	3.58 (1.91, 6.60)

Supplementary Table 5 (continued). Distribution of Missing Work-Related Injury and Illness (DART) Rates, Predictors of Missing Data, and Distributions of Observed and Imputed Values

	Nursing Home-Years with Missing Data	Adjusted PR [‡] (95% CI)	Distribution of DART Rates among Observed Values	Distribution of DART Rates among Imputed Values
	% [†]		Median [†] (25 th , 75 th Percentile)	Median [†] (25 th , 75 th Percentile)
Central county, large metropolitan area (1M+)	30.3%	(ref)	5.41 (2.81, 8.61)	3.46 (1.83, 6.41)
Fringe county, large metropolitan area (1M+)	25.2%	0.96 (0.91–1.00)	6.61 (3.90, 10.00)	4.03 (2.20, 7.32)
Medium metropolitan area (250,000-999,999)	23.6%	0.94 (0.90–0.99)	7.51 (4.44, 11.31)	4.44 (2.40, 8.10)
Small metropolitan area (100,000-249,999)	23.0%	0.92 (0.86–0.98)	7.56 (4.15, 11.64)	4.12 (2.19, 7.57)
Micropolitan area (50,000-99,999)	23.1%	0.95 (0.90–1.01)	7.00 (3.85, 11.03)	4.03 (2.14, 7.45)
Rural counties	25.6%	1.10 (1.03–1.18)	6.20 (3.09, 10.10)	3.52 (1.86, 6.55)
Aggregated resident characteristics, categorized into quartiles [§]				
Mean resident weight				
38.9 to 66.9 kg	19.5%	0.99 (0.93–1.05)	6.81 (3.84, 10.48)	3.92 (2.09, 7.26)
67 to 69.9 kg	24.6%	0.99 (0.95–1.04)	6.77 (3.86, 10.50)	4.01 (2.13, 7.33)
70 to 72.9 kg	27.8%	0.99 (0.95–1.03)	6.54 (3.60, 10.19)	3.97 (2.13, 7.26)
73 to 179.8 kg	32.2%	(ref)	5.98 (3.13, 9.76)	3.69 (1.96, 6.83)
Mean resident age				
32.5 to 77.9 years	30.2%	0.95 (0.88–1.02)	5.80 (2.86, 9.60)	3.51 (1.84, 6.57)
78 to 80.9 years	26.2%	0.99 (0.93–1.05)	6.59 (3.63, 10.52)	4.03 (2.16, 7.38)
81 to 83.9 years	23.5%	0.98 (0.93–1.02)	7.05 (4.05, 10.82)	4.11 (2.20, 7.52)
84 to 94.7 years	23.0%	(ref)	6.68 (3.90, 10.06)	4.01 (2.17, 7.28)
Proportion dependent in activities of daily living				
0% to 64.9%	25.7%	1.10 (1.05–1.16)	5.84 (2.89, 9.77)	3.33 (1.74, 6.25)
65% to 73.9%	24.4%	1.06 (1.01–1.10)	6.67 (3.72, 10.43)	3.88 (2.08, 7.15)
74% to 81.9%	25.1%	1.02 (0.98–1.06)	6.84 (3.90, 10.41)	4.10 (2.19, 7.48)
82% to 100%	27.3%	(ref)	6.91 (4.08, 10.52)	4.25 (2.31, 7.68)
Proportion who resist care and are not easily modified				
0% to 4.9%	28.4%	0.98 (0.94–1.02)	6.30 (3.47, 9.79)	3.92 (2.10, 7.16)
5% to 9.9%	25.7%	0.98 (0.94–1.02)	6.67 (3.79, 10.42)	3.96 (2.12, 7.25)
10% to 15.9%	24.0%	0.97 (0.93–1.01)	6.81 (3.83, 10.59)	3.98 (2.12, 7.30)
16% to 99.3%	24.3%	(ref)	6.57 (3.46, 10.34)	3.71 (1.95, 6.97)

Supplementary Table 5 (continued). Distribution of Missing Work-Related Injury and Illness (DART) Rates, Predictors of Missing Data, and Distributions of Observed and Imputed Values

	Nursing Home-Years with Missing Data	Adjusted PR [‡] (95% CI)	Distribution of DART Rates among Observed Values	Distribution of DART Rates among Imputed Values
	% [†]		Median [†] (25 th , 75 th Percentile)	Median [†] (25 th , 75 th Percentile)
Proportion with conflicted relationships with staff				
0%	29.4%	1.06 (1.01–1.11)	5.88 (2.87, 9.76)	3.52 (1.85, 6.54)
0.1% to 0.9%	25.8%	0.95 (0.92–0.99)	6.61 (3.75, 10.21)	3.98 (2.16, 7.22)
1.0% to 2.9%	24.4%	0.97 (0.93–1.00)	6.82 (3.92, 10.47)	4.06 (2.18, 7.45)
3.0% to 88.3%	25.1%	(ref)	6.56 (3.56, 10.36)	3.82 (2.01, 7.11)
Proportion with loss of use of one or both legs				
0% to 19.9%	27.4%	0.96 (0.92–1.00)	6.24 (3.41, 9.87)	3.71 (1.96, 6.84)
20% to 27.9%	25.2%	0.95 (0.91–0.99)	6.73 (3.81, 10.32)	4.04 (2.17, 7.41)
28% to 36.9%	25.1%	0.99 (0.95–1.03)	6.86 (3.89, 10.61)	4.01 (2.15, 7.36)
37% to 100%	24.8%	(ref)	6.50 (3.48, 10.39)	3.83 (2.03, 7.10)
Proportion who require mechanical lifting				
0% to 5.9%	25.3%	1.16 (1.11–1.22)	5.78 (2.73, 9.42)	3.26 (1.68, 6.21)
6% to 11.9%	25.6%	1.09 (1.05–1.14)	6.81 (3.85, 10.55)	3.98 (2.14, 7.27)
12% to 18.9%	25.7%	1.04 (1.01–1.09)	6.92 (4.04, 10.59)	4.13 (2.24, 7.49)
19% to 96.9%	25.9%	(ref)	6.71 (3.84, 10.39)	4.13 (2.23, 7.50)
Proportion who have fallen in the last 30 days and/or had a hip fracture in the last 180 days				
0% to 14.9%	29.6%	1.02 (0.97–1.08)	4.69 (2.20, 8.10)	2.99 (1.56, 5.63)
15% to 19.9%	24.9%	0.98 (0.94–1.03)	6.71 (3.73, 10.41)	3.91 (2.09, 7.16)
20% to 24.9%	23.5%	0.95 (0.92–0.99)	7.21 (4.26, 10.93)	4.36 (2.40, 7.88)
25% to 60.7%	25.5%	(ref)	7.26 (4.41, 10.89)	4.43 (2.42, 7.98)
Proportion with dementia and/or Alzheimer's				
0% to 39.9%	28.2%	1.05 (1.00–1.10)	6.21 (3.36, 9.90)	3.81 (2.02, 7.05)
40% to 49.9%	25.1%	1.01 (0.97–1.06)	6.81 (3.79, 10.57)	3.96 (2.12, 7.29)
50% to 57.9%	24.3%	1.00 (0.95–1.04)	6.66 (3.73, 10.35)	3.95 (2.11, 7.27)
58% to 100%	24.3%	(ref)	6.66 (3.69, 10.30)	3.84 (2.04, 7.07)

Supplementary Table 5 (continued). Distribution of Missing Work-Related Injury and Illness (DART) Rates, Predictors of Missing Data, and Distributions of Observed and Imputed Values

	Nursing Home-Years with Missing Data	Adjusted PR [‡] (95% CI)	Distribution of DART Rates among Observed Values	Distribution of DART Rates among Imputed Values
	% [†]		Median [†] (25 th , 75 th Percentile)	Median [†] (25 th , 75 th Percentile)
Proportion with bipolar depression				
0% to 0.9%	24.4%	1.02 (0.96–1.08)	6.75 (3.99, 10.17)	4.09 (2.23, 7.40)
1% to 1.9%	24.1%	0.98 (0.93–1.04)	6.96 (3.99, 10.57)	4.23 (2.27, 7.72)
2% to 4.9%	25.1%	1.00 (0.96–1.04)	6.76 (3.76, 10.65)	4.02 (2.15, 7.35)
5% to 100%	28.6%	(ref)	5.83 (2.84, 9.75)	3.42 (1.79, 6.41)
Proportion with high grade (2-4) pressure ulcers				
0% to 5.9%	27.3%	1.07 (1.02–1.12)	6.04 (3.10, 9.70)	3.57 (1.87, 6.68)
6% to 8.9%	24.7%	0.99 (0.95–1.03)	6.79 (3.83, 10.58)	3.95 (2.11, 7.26)
9% to 11.9%	24.2%	0.96 (0.92–1.00)	6.99 (4.00, 10.62)	4.11 (2.22, 7.51)
12% to 53.5%	26.7%	(ref)	6.40 (3.51, 10.06)	3.92 (2.10, 7.19)
Proportion restrained				
0% to 1.9%	29.8%	0.92 (0.88–0.96)	6.36 (3.67, 9.78)	4.00 (2.14, 7.25)
2% to 5.9%	26.2%	0.89 (0.86–0.94)	7.02 (3.97, 10.73)	4.05 (2.18, 7.41)
6% to 17.9%	23.4%	0.92 (0.88–0.96)	6.93 (3.89, 10.83)	3.92 (2.10, 7.22)
18% to 100%	22.5%	(ref)	6.08 (3.10, 9.94)	3.52 (1.83, 6.69)
Proportion who have taken antipsychotics in the last week				
0% to 15.9%	27.1%	1.03 (0.98–1.09)	6.67 (3.95, 10.24)	4.14 (2.25, 7.48)
16% to 21.9%	24.3%	1.01 (0.96–1.06)	6.85 (3.91, 10.40)	4.09 (2.21, 7.44)
22% to 28.9%	24.4%	1.01 (0.97–1.06)	6.70 (3.75, 10.51)	3.98 (2.13, 7.34)
29% to 100%	26.9%	(ref)	6.01 (2.91, 9.94)	3.40 (1.77, 6.42)
Proportion of residents who are Asian				
0%	23.4%	1.00 (0.95–1.06)	6.94 (3.83, 10.80)	3.94 (2.09, 7.26)
0.1% to 0.9%	25.8%	0.95 (0.89–1.00)	6.75 (4.00, 10.19)	4.19 (2.28, 7.61)
1.0% to 1.9%	29.8%	1.02 (0.96–1.09)	5.74 (3.07, 9.18)	3.79 (2.04, 6.96)
2.0% to 100%	34.4%	(ref)	4.77 (2.26, 7.77)	3.18 (1.66, 5.96)

Supplementary Table 5 (continued). Distribution of Missing Work-Related Injury and Illness (DART) Rates, Predictors of Missing Data, and Distributions of Observed and Imputed Values

	Nursing Home-Years with Missing Data	Adjusted PR [‡] (95% CI)	Distribution of DART Rates among Observed Values	Distribution of DART Rates among Imputed Values
	% [†]		Median [†] (25 th , 75 th Percentile)	Median [†] (25 th , 75 th Percentile)
Proportion of residents who are Black				
0%	22.2%	0.89 (0.84–0.95)	7.27 (4.03, 11.13)	4.03 (2.15, 7.44)
0.1% to 2.9%	22.5%	0.84 (0.81–0.89)	7.49 (4.54, 11.29)	4.41 (2.38, 8.03)
3% to 12.9%	26.8%	0.92 (0.88–0.95)	6.43 (3.68, 10.04)	3.97 (2.14, 7.26)
13% to 100%	30.6%	(ref)	5.11 (2.57, 8.39)	3.36 (1.78, 6.23)
Proportion of residents who are Hispanic				
0%	22.7%	0.93 (0.88–0.97)	6.94 (3.84, 10.84)	3.98 (2.12, 7.35)
0.1% to 0.9%	23.4%	0.89 (0.85–0.93)	7.21 (4.38, 10.73)	4.39 (2.41, 7.92)
1.0% to 2.9%	26.4%	0.95 (0.91–1.00)	6.66 (3.76, 10.24)	3.99 (2.11, 7.33)
3.0% to 100%	32.1%	(ref)	5.17 (2.56, 8.57)	3.38 (1.79, 6.27)

[†]DART rate: work-related injuries and illnesses resulting in Days Away from work, Restriction of job activities, or Transfer to another position, per 100 FTE's per year.

[†] Percent of nursing home-years, medians, 25th and 75th percentiles are weighted by the staff size of the nursing homes.

[‡] Prevalence ratio for missing DART rate. Weighted by the staff size of the nursing homes, with a generalized estimating equation specification (m-dependent correlation matrix) to account for repeated measures for each nursing home. 95% confidence intervals generated from model-based standard error estimates. Simultaneously adjusted for all factors listed in the table.

[§] Quartile boundaries rounded to the nearest whole percentage.

Supplementary Table 6. Nursing Home Characteristics in 2002, 2010, by Safe Patient Handling and Movement (SPHM) Legislation Status

Nursing Home Characteristics	SPHM Legislation Adoption States		States with no SPHM Legislation	
	2002	2010	2002	2010
	% [†]	% [†]	% [†]	% [†]
For profit	65.6%	68.4%	73.2%	74.2%
Part of a chain	42.6%	44.1%	57.8%	58.4%
	Median [‡] (25 th , 75 th Percentile)			
Bed size	148 (105, 203)	140 (101, 200)	120 (95, 160)	120 (95, 159)
Nurse:bed ratio	0.61 (0.53, 0.70)	0.66 (0.58, 0.75)	0.61 (0.52, 0.70)	0.66 (0.57, 0.77)
Ratio of registered nurses to other nursing staff	0.18 (0.13, 0.23)	0.18 (0.14, 0.24)	0.17 (0.12, 0.24)	0.18 (0.13, 0.25)
Aggregated resident characteristics [§]				
Mean resident weight (kilograms)	66.9 (64.5, 69.4)	72.1 (69.4, 75.6)	66.5 (64.4, 68.8)	72.2 (69.5, 75.1)
Mean resident age (years)	81.9 (79.0, 84.1)	80.5 (76.4, 83.6)	82.1 (79.4, 84.3)	80.9 (77.1, 83.7)
% Hispanic, of any race	0.7% (0.0%, 3.1%)	1.2% (0.0%,4.8%)	0.2% (0.0%,1.5%)	0.6% (0.0%,2.5%)
% Non-Hispanic Asian or Pacific Islander	0.0% (0.0%, 0.7%)	0.2% (0.0%, 1.0%)	0.0% (0.0%, 0.4%)	0.0% (0.0%,0.7%)
% Non-Hispanic Black	3.8%(0.7%,13.2%)	5.6%(1.3%,17.2%)	2.5%(0.2%,10.9%)	3.5%(0.5%,13.6%)
% Non-Hispanic White	93.3% (77.6%, 98.1%)	89.1% (68.2%, 96.7%)	95.0% (82.4%, 98.9%)	92.6% (76.1%, 98.1%)
% dependent in activities of daily living	72.2% (65.3%, 79.2%)	79.3% (71.2%, 86.9%)	69.5% (61.0%, 77.7%)	78.3% (69.0%, 86.0%)
% Resist care and are not easily modified	11.6%(6.2%,18.9%)	8.9% (4.5%, 15.9%)	11.3%(6.4%,17.6%)	7.4%(3.6%,13.3%)
% Have conflicted relations with staff	1.8% (0.7%,4.1%)	4% (0.3%, 3.4%)	1.6%(0.5%,3.7%)	1.1% (0.3%,3.0%)
% Have lost use of one or both legs	31.2% (22.9%, 40.4%)	26.2% (18.8%, 35.4%)	31.1% (22.9%, 40.3%)	26.0% (17.6%, 35.2%)
% Require manual lifting	13.5% (5.8%, 27.3%)	8.0% (2.1%, 24.3%)	15.2% (6.2%, 28.8%)	8.3% (1.6%, 25.8%)
% Require mechanical lifting	10.3% (4.6%, 17.5%)	15.8% (10.0%, 22.3%)	8.5% (3.9%, 15.2%)	15.6% (9.5%, 23.0%)
% Fell in last 30 days, or hip fracture in last 180 days	18.7% (14.4%, 22.7%)	20.0% (15.2%, 24.2%)	20.0% (15.6%, 24.2%)	21.0% (16.6%, 25.7%)
% Have dementia and/or Alzheimer's-	46.7% (37.4%, 54.8%)	45.8% (36.6%, 54.7%)	48.7% (40.0%, 57.3%)	47.2% (38.0%, 56.4%)
% Have bipolar depression	2.1% (0.8%,4.7%)	2.8% (1.1%,6.4%)	2.1% (0.8%,4.4%)	2.4% (0.9%,5.5%)

Supplementary Table 6 (continued). Nursing Home Characteristics in 2002, 2010, by Safe Patient Handling and Movement (SPHM) Legislation

Status	2002	2010	2002	2010	2002	2010		
% Have a high grade pressure ulcer	9.4%	(6.7%,12.6%)	8.7%	(6.2%,11.8%)	8.7%	(6.1%,11.5%)	8.0%	(5.7%,10.6%)
% Restrained (more than a single bed rail)	13.1%	(5.4%,33.7%)	1.7%	(0.5%,4.6%)	20.4%	(7.2%, 49.2%)	1.6%	(0.3%,4.7%)
% Given antipsychotics in the last week	21.7%	(16.6%,28.1%)	20.2%	(14.7%,27.6%)	21.8%	(16.6%,28.2%)	21.0%	(14.9%,28.4%)

* Hawaii, Maryland, Minnesota, New Jersey, New York, Ohio, Rhode Island and Texas.

† Percents weighted by size of nursing home staff.

‡ Medians, 25th and 75th percentiles are weighted by size of nursing home staff.

§ Quarterly resident aggregates of means (age, weight), and proportions of residents dependent in activities of daily living (3-6 on the Inter-RAI ADL Hierarchy Scale), resisting care and not easily modified (MDS items E4ea, E4eb), having conflicted relationships with staff (F2a), loss of use of one or both legs (G4da, G4db), requiring manual lifting (G6c), mechanical lifting (G6d), recent fall or hip fracture (J4a, J4c), diagnosed with dementia or Alzheimer's (I1q, I1u), diagnosed with schizophrenia (I1gg), a high grade (2-4) pressure ulcer (M2a), any use of restraints more restrictive than a single bed rail (P4a, P4c, P4d, P4e), or use of antipsychotics in the last week (O4a). We also tabulated the proportion of residents identified as Native American, Asian or Pacific Islander, Black, Hispanic or White (AA4). We then averaged across 4 quarters (3 in 2010) to obtain annual aggregates of resident characteristics.

Supplementary Table 7. Difference-in-Difference Estimates for the Impact of Safe Patient Handling and Movement (SPHM) Legislation, Restricted to a High Contrast* Comparison

	Crude RR [†] (95% CI)	Adjusted RR [‡] (95% CI)
All nursing homes	1.08 (0.90–1.30)	1.08 (0.91–1.27)
Stratified by nursing home characteristics		
Bed size		
Under 100 beds	1.03 (0.87–1.23)	1.09 (0.87–1.35)
100-299 beds	1.06 (0.92–1.23)	1.07 (0.91–1.26)
300+ beds	1.08 (0.70–1.66)	1.13 (0.70–1.82)
For profit	1.06 (0.91–1.23)	1.06 (0.92–1.22)
Non-profit	1.11 (0.87–1.42)	1.09 (0.88–1.34)
Member of a chain	1.12 (0.87–1.44)	1.10 (0.89–1.37)
Not a member of a chain	1.05 (0.91–1.21)	1.05 (0.91–1.20)
Nurse:bed ratio		
0.05 to 0.50	1.20 (0.79–1.82)	1.04 (0.93–1.15)
0.50 to 0.70	1.04 (0.93–1.17)	1.20 (0.79–1.84)
0.70 to 2.51	1.17 (0.86–1.59)	1.15 (0.87–1.51)
Ratio of registered nurses to other nursing staff		
0.01 to 0.15	1.03 (0.88–1.20)	1.04 (0.90–1.21)
0.15 to 0.25	1.04 (0.94–1.14)	1.01 (0.94–1.08)
0.25 to 2.59	1.14 (0.85–1.54)	1.13 (0.86–1.47)
Population size of metropolitan area		
Large (1,000,000 and higher)	1.13 (0.88–1.45)	1.10 (0.90–1.36)
Medium or small (100,000-999,999)	1.05 (0.85–1.30)	1.01 (0.93–1.10)
Micropolitan or rural area	1.04 (0.86–1.26)	1.04 (0.87–1.23)

*SPHM States restricted to four states with legislation requiring nursing homes to develop a safe patient handling policy, guidelines for lift teams/equipment, staff education & training, and a data collection/ evaluation requirement: Maryland, Minnesota, New Jersey and Rhode Island. Three states that adopted legislation affecting nursing homes (Illinois), or hospitals only (California, Missouri) after 2010 excluded from the non-SPHM legislation states.

[†]Ratio of work-related injury and illness rates during the post-enactment period (2008-2010) to the pre-enactment period (2002-2003) among SPHM states relative to the ratio during the post-enactment period to the pre-enactment period in states with no SPHM legislation. Pooled across 50 multiply imputed datasets, weighted by the staff size of the nursing homes, and with a generalized estimating equation specification (m-dependent correlation matrix) to account for repeated measures for each nursing home. 95% confidence intervals generated from model-based standard error estimates.

[‡]As above, and adjusted for state, year, urbanicity, calendar year, and the following time-varying covariates: profit orientation, chain membership, nursing home bed size, nurse:bed ratio, ratio of registered nurses to other nursing staff, mean resident weight, mean resident age, percent of residents with: severe activities of daily living limitations, require mechanical lifting, resist care and are not easily modified, have conflicted relationships with staff, restrained, loss of movement in one or both legs, had fallen in the previous 30 days and/or had a hip fracture in the previous 180 days, had dementia and/or Alzheimer's, had bipolar depression, had a high grade (2-4) pressure ulcer, used antipsychotics in the previous week, and resident proportion Asian, proportion Black, and proportion Hispanic.

Supplementary Table 8. Difference-in-Difference Estimates for the Impact of Safe Patient Handling and Movement (SPHM) Legislation, Restricted to Neighboring States[†]

	Crude RR (95% CI)	Adjusted RR [†] (95% CI)
All nursing homes	1.06 (0.93–1.22)	1.05 (0.94–1.17)
Stratified by nursing home characteristics		
Bed size		
Under 100 beds	1.00 (0.89–1.12)	1.02 (0.92–1.14)
100-299 beds	1.04 (0.94–1.16)	1.05 (0.94–1.19)
300+ beds	1.06 (0.80–1.39)	1.05 (0.80–1.36)
For profit	1.05 (0.93–1.19)	1.04 (0.94–1.16)
Non-profit	1.07 (0.91–1.27)	1.05 (0.92–1.19)
Member of a chain	1.03 (0.93–1.14)	1.03 (0.94–1.12)
Not a member of a chain	1.09 (0.91–1.30)	1.06 (0.93–1.22)
Nurse:bed ratio		
0.05 to 0.50	0.96 (0.82–1.14)	1.00 (0.88–1.14)
0.50 to 0.70	1.07 (0.92–1.23)	1.05 (0.94–1.17)
0.70 to 2.51	1.10 (0.90–1.34)	1.07 (0.92–1.24)
Ratio of registered nurses to other nursing staff		
0.01 to 0.15	1.04 (0.92–1.17)	1.04 (0.93–1.16)
0.15 to 0.25	1.06 (0.92–1.23)	1.05 (0.93–1.18)
0.25 to 2.59	1.10 (0.89–1.36)	1.06 (0.91–1.24)
Population size of metropolitan area		
Large (1,000,000 and higher)	1.12 (0.88–1.42)	1.11 (0.89–1.38)
Medium or small (100,000-999,999)	1.04 (0.92–1.19)	1.03 (0.93–1.14)
Micropolitan or rural area	0.96 (0.82–1.11)	0.92 (0.76–1.12)

[†]SPHM States exclude Hawaii (which has no contiguous neighbors). Non-SPHM legislation states restricted to those bordering at least one SPHM legislation state, namely: Arkansas, Connecticut, Delaware, District of Columbia, Indiana, Iowa, Kentucky, Louisiana, Massachusetts, Michigan, New Mexico, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont, West Virginia and Wisconsin.

[†]Ratio of work-related injury and illness rates during the post-enactment period (2008-2010) to the pre-enactment period (2002-2003) among SPHM states relative to the ratio during the post-enactment period to the pre-enactment period in states with no SPHM legislation. Pooled across 50 multiply imputed datasets, weighted by the staff size of the nursing homes, and with a generalized estimating equation specification (m-dependent correlation matrix) to account for repeated measures for each nursing home. 95% confidence intervals generated from model-based standard error estimates.

[‡]As above, and adjusted for state, year, urbanicity, calendar year, and the following time-varying covariates: profit orientation, chain membership, nursing home bed size, nurse:bed ratio, ratio of registered nurses to other nursing staff, mean resident weight, mean resident age, percent of residents with: severe activities of daily living limitations, require mechanical lifting, resist care and are not easily modified, have conflicted relationships with staff, restrained, loss of movement in one or both legs, had fallen in the previous 30 days and/or had a hip fracture in the previous 180 days, had dementia and/or Alzheimer's, had bipolar depression, had a high grade (2-4) pressure ulcer, used antipsychotics in the previous week, and resident proportion Asian, proportion Black, and proportion Hispanic.

Supplementary Table 9. Difference-in-Difference Estimates for the Impact of Safe Patient Handling and Movement (SPHM) Legislation, Restricted to Observed Values

	Crude RR [*] (95% CI)	Adjusted RR [†] (95% CI)
All nursing homes	1.04 (0.99–1.09)	1.02 (0.98–1.06)
Stratified by nursing home characteristics		
Bed size		
Under 100 beds	0.98 (0.88–1.09)	1.00 (0.91–1.10)
100-299 beds	1.03 (0.98–1.09)	1.03 (0.98–1.08)
300+ beds	0.91 (0.76–1.10)	0.91 (0.77–1.08)
For profit	1.02 (0.95–1.09)	1.01 (0.96–1.06)
Non-profit	1.06 (0.97–1.16)	1.03 (0.96–1.10)
Member of a chain	1.02 (0.95–1.10)	1.02 (0.96–1.09)
Not a member of a chain	1.04 (0.97–1.11)	1.01 (0.95–1.07)
Nurse:bed ratio		
0.05 to 0.50	1.02 (0.90–1.15)	1.04 (0.93–1.16)
0.50 to 0.70	1.01 (0.95–1.07)	1.00 (0.94–1.05)
0.70 to 2.51	1.09 (1.01–1.18)	1.05 (0.99–1.13)
Ratio of registered nurses to other nursing staff		
0.01 to 0.15	1.00 (0.92–1.08)	0.99 (0.93–1.06)
0.15 to 0.25	1.07 (1.00–1.14)	1.05 (0.99–1.11)
0.25 to 2.59	1.06 (0.96–1.17)	1.02 (0.93–1.11)
Population size of metropolitan area		
Large (1,000,000 and higher)	1.11 (1.04–1.19)	1.07 (1.01–1.14)
Medium or small (100,000-999,999)	1.02 (0.93–1.11)	1.02 (0.95–1.10)
Micropolitan or rural area	0.93 (0.83–1.04)	0.90 (0.82–0.99)

* Ratio of work-related injury and illness rates during the post-enactment period (2008-2010) to the pre-enactment period (2002-2003) among SPHM states relative to the ratio during the post-enactment period to the pre-enactment period in states with no SPHM legislation. Pooled across 50 multiply imputed datasets, weighted by the staff size of the nursing homes, and with a generalized estimating equation specification (m-dependent correlation matrix) to account for repeated measures for each nursing home. 95% confidence intervals generated from model-based standard error estimates.

† As above, and adjusted for state, year, urbanicity, calendar year, and the following time-varying covariates: profit orientation, chain membership, nursing home bed size, nurse:bed ratio, ratio of registered nurses to other nursing staff, mean resident weight, mean resident age, percent of residents with: severe activities of daily living limitations, require mechanical lifting, resist care and are not easily modified, have conflicted relationships with staff, restrained, loss of movement in one or both legs, had fallen in the previous 30 days and/or had a hip fracture in the previous 180 days, had dementia and/or Alzheimer's, had bipolar depression, had a high grade (2-4) pressure ulcer, used antipsychotics in the previous week, and resident proportion Asian, proportion Black, and proportion Hispanic.

Supplementary Table 10. Difference-in-Difference Estimates for the Impact of Safe Patient Handling and Movement (SPHM) Legislation, Missing Values Singly Imputed*

	Crude RR [†] (95% CI)	Adjusted RR [‡] (95% CI)
All nursing homes	1.05 (1.01–1.10)	1.03 (0.99–1.07)
Stratified by nursing home characteristics		
Bed Size <100 beds	1.00 (0.91–1.10)	1.01 (0.93–1.10)
100-299 beds	1.04 (0.99–1.09)	1.04 (0.99–1.08)
300+ beds	0.95 (0.81–1.12)	0.94 (0.81–1.10)
For profit	1.03 (0.97–1.09)	1.01 (0.97–1.06)
Non-profit	1.07 (1.00–1.15)	1.05 (0.99–1.11)
Member of a chain	1.04 (0.97–1.11)	1.03 (0.98–1.09)
Not a member of a chain	1.05 (0.99–1.11)	1.01 (0.97–1.06)
Nurse:bed ratio		
0.05 to 0.50	1.02 (0.92–1.13)	1.04 (0.96–1.14)
0.50 to 0.70	1.02 (0.97–1.08)	1.00 (0.96–1.05)
0.70 to 2.51	1.11 (1.03–1.18)	1.06 (1.00–1.12)
Ratio of registered nurses to other nursing staff		
0.01 to 0.15	1.00 (0.93–1.07)	0.99 (0.94–1.05)
0.15 to 0.25	1.08 (1.02–1.15)	1.05 (1.00–1.10)
0.25 to 2.59	1.09 (1.00–1.19)	1.04 (0.97–1.12)
Population size of metropolitan area		
Large (1,000,000 and higher)	1.12 (1.06–1.19)	1.08 (1.03–1.14)
Medium or small (100,000-999,999)	1.04 (0.96–1.12)	1.02 (0.95–1.09)
Micropolitan or rural area	0.93 (0.84–1.03)	0.91 (0.84–0.98)

*Missing values were singly imputed using linear interpolation, or if no DART rate was available after 2008, by carrying the last observation forward.

[†]Ratio of work-related injury and illness rates during the post-enactment period (2008-2010) to the pre-enactment period (2002-2003) among SPHM states relative to the ratio during the post-enactment period to the pre-enactment period in states with no SPHM legislation. Pooled across 50 multiply imputed datasets, weighted by the staff size of the nursing homes, and with a generalized estimating equation specification (m-dependent correlation matrix) to account for repeated measures for each nursing home. 95% confidence intervals generated from model-based standard error estimates.

[‡]As above, and adjusted for state, year, urbanicity, calendar year, and the following time-varying covariates: profit orientation, chain membership, nursing home bed size, nurse:bed ratio, ratio of registered nurses to other nursing staff, mean resident weight, mean resident age, percent of residents with: severe activities of daily living limitations, require mechanical lifting, resist care and are not easily modified, have conflicted relationships with staff, restrained, loss of movement in one or both legs, had fallen in the previous 30 days and/or had a hip fracture in the previous 180 days, had dementia and/or Alzheimer's, had bipolar depression, had a high grade (2-4) pressure ulcer, used antipsychotics in the previous week, and resident proportion Asian, proportion Black, and proportion Hispanic.

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