

Supplementary Materials

Table S1. Search strategy for the different sources considered.

Source	Search Strategy
PubMed	<p>("Supine Position"[Mesh] OR "Sitting Position"[Mesh] OR "Prone Position"[Mesh] OR "Supine Position"[Text word] OR "Sitting Position"[Text word] OR "Prone Position"[Text word] OR "posture"[MeSH Terms] OR Posture[Text Word] OR "accidental falls"[MeSH Terms] OR falls [Text Word] OR "pressure ulcer"[MeSH Terms] OR bedsore[Text Word] OR "pressure ulcer"[Text Word] OR "sleep"[MeSH Terms] OR sleep[Text Word] OR "heart rate"[MeSH Terms] OR "heart rate"[Text Word] OR "movement"[MeSH Terms] OR Movement[Text Word])</p> <p>AND</p> <p>("beds"[MeSH Terms] OR bed*[Text Word])</p> <p>AND</p> <p>("signal processing, computer-assisted"[MeSH Terms] OR "monitoring, physiologic"[MeSH Terms] OR "pattern recognition, automated"[MeSH Terms] OR "artificial intelligence"[MeSH Terms] OR artificial intelligence[Text Word] OR "machine learning"[MeSH Terms] OR machine learning[Text Word] OR "Deep Learning"[Mesh] OR "Deep Learning"[Text Word] OR "data mining"[MeSH Terms] OR data mining[Text Word])</p>
Scopus	<p>(TITLE-ABS-KEY ("Supine Position") OR TITLE-ABS-KEY ("Sitting Position") OR TITLE-ABS-KEY "Prone Position" OR TITLE-ABS-KEY (posture) OR TITLE-ABS-KEY (falls) OR TITLE-ABS-KEY (bedsore) OR TITLE-ABS-KEY ("pressure ulcer") OR TITLE-ABS-KEY (sleep) OR TITLE-ABS-KEY ("heart rate") OR OR TITLE-ABS-KEY (movement)) AND (TITLE-ABS-KEY (bed*)) AND (TITLE-ABS-KEY ("artificial intelligence") OR TITLE-ABS-KEY ("machine learning") OR TITLE-ABS-KEY ("Deep Learning") OR TITLE-ABS-KEY ("data mining")))</p>
Embase	<p>(exp "Supine Position"/ or exp "Sitting Position"/ or exp "Prone Position"/ or "Supine Position".mp. or "Sitting Position".mp. or "Prone Position"[Text word].mp. or exp posture/ or Posture.mp. or exp "accidental falls"/ or falls.mp. or exp "pressure ulcer"/ or bedsore.mp. or "pressure ulcer".mp. or exp sleep/ or sleep.mp. or exp "heart rate"/ or "heart rate".mp. or exp movement/ or Movement.mp.) and (exp beds/ or bed*.mp.) and (exp "signal processing, computer-assisted"/ or exp "monitoring, physiologic"/ or exp "pattern recognition, automated"/ or exp "artificial intelligence"/ or "artificial intelligence".mp. or exp "machine learning"/ or "machine learning".mp. or exp "Deep Learning"/ or "Deep Learning".mp. or exp "data mining"/ or "data mining".mp.) [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]</p>
CINAHL	<p>((MH "Supine Position"+) OR (MH "Sitting Position"+) OR (MH "Prone Position"+) OR "Supine Position" OR "Sitting Position" OR "Prone Position"[Text word] OR (MH posture+) OR Posture OR (MH "accidental falls"+) OR falls OR (MH "pressure ulcer"+) OR bedsore OR "pressure ulcer" OR (MH sleep+) OR sleep OR (MH "heart rate"+) OR "heart rate" OR (MH movement+) OR Movement)</p> <p>AND</p> <p>((MH beds+) OR bed*)</p> <p>AND</p> <p>((MH "signal processing, computer-assisted"+) OR (MH "monitoring, physiologic"+) OR (MH "pattern recognition, automated"+) OR (MH "artificial intelligence"+) OR "artificial intelligence" OR (MH "machine learning"+) OR "machine learning" OR (MH "Deep Learning"+) OR "Deep Learning" OR (MH "data mining"+) OR "data mining")</p>

Cochrane central	(exp "Supine Position"/ or exp "Sitting Position"/ or exp "Prone Position"/ or "Supine Position".mp. or "Sitting Position".mp. or "Prone Position[Text word]".mp. or exp posture/ or Posture.mp. or exp "accidental falls"/ or falls.mp. or exp "pressure ulcer"/ or bedsore.mp. or "pressure ulcer".mp. or exp sleep/ or sleep.mp. or exp "heart rate"/ or "heart rate".mp. or exp movement/ or Movement.mp.) and (exp beds/ or bed*.mp.) and (exp "signal processing, computer-assisted"/ or exp "monitoring, physiologic"/ or exp "pattern recognition, automated"/ or exp "artificial intelligence"/ or "artificial intelligence".mp. or exp "machine learning"/ or "machine learning".mp. or exp "Deep Learning"/ or "Deep Learning".mp. or exp "data mining"/ or "data mining".mp.) [mp=title, original title, abstract, mesh headings, heading words, keyword]
IEEX	("Supine Position" OR "Sitting Position" OR "Prone Position" OR Posture OR "accidental falls" OR falls OR "pressure ulcer" OR bedsore OR "pressure ulcer" OR "sleep" OR "heart rate" OR "movement") AND (bed*) AND ("signal processing computer-assisted" OR "monitoring physiologic" OR "pattern recognition automated" OR "artificial intelligence" OR machine learning OR "Deep Learning" OR data mining)
ACM	[[Abstract: "supine position"] OR [Abstract: "sitting position"] OR [Abstract: "prone position"] OR [Abstract: posture] OR [Abstract: "accidental falls"] OR [Abstract: falls] OR [Abstract: "pressure ulcer"] OR [Abstract: bedsore] OR [Abstract: "pressure ulcer"] OR [Abstract: "sleep"] OR [Abstract: "heart rate"] OR [Abstract: "movement"]] AND [Abstract: bed*] AND [[Abstract: "signal processing computer-assisted"] OR [Abstract: "monitoring physiologic"] OR [Abstract: "pattern recognition automated"] OR [Abstract: "artificial intelligence"] OR [Abstract: machine learning] OR [Abstract: "deep learning"] OR [Abstract: data mining]] OR [[Title: "supine position"] OR [Title: "sitting position"] OR [Title: "prone position"] OR [Title: posture] OR [Title: "accidental falls"] OR [Title: falls] OR [Title: "pressure ulcer"] OR [Title: bedsore] OR [Title: "pressure ulcer"] OR [Title: "sleep"] OR [Title: "heart rate"] OR [Title: "movement"]] AND [Title: bed*] AND [[Title: "signal processing computer-assisted"] OR [Title: "monitoring physiologic"] OR [Title: "pattern recognition automated"] OR [Title: "artificial intelligence"] OR [Title: machine learning] OR [Title: "deep learning"] OR [Title: data mining]]
asXiv	("Supine Position" OR "Sitting Position" OR "Prone Position" OR Posture OR "accidental falls" OR falls OR "pressure ulcer" OR bedsore OR "pressure ulcer" OR "sleep" OR "heart rate" OR "movement") AND (bed*)
Web of Science	ALL=("signal processing computer-assisted" OR "monitoring physiologic" OR "pattern recognition automated" OR "artificial intelligence" OR machine learning OR "Deep Learning" OR data mining) AND (ALL=(bed*)) AND ALL=("Supine Position" OR "Sitting Position" OR "Prone Position" OR Posture OR "accidental falls" OR falls OR "pressure ulcer" OR bedsore OR "pressure ulcer" OR "sleep" OR "heart rate" OR "movement")

Table S2. Summary of the 56 study included according to outcome.

Characteristic	N	Overall N = 78 ¹	Other N = 3 ¹	Position Estimation N = 48 ¹	Sleep and Vigilance N = 19 ¹	Vital Signs N = 8 ¹
Input data	78					
Acceleration data		6 (7.7%)	1 (33%)	2 (4.2%)	3 (16%)	0 (0%)
Multiple input data		12 (15%)	0 (0%)	7 (15%)	5 (26%)	0 (0%)
Other		5 (6.4%)	0 (0%)	1 (2.1%)	4 (21%)	0 (0%)
Pressure data		30 (38.3%)	2 (67%)	22 (46.1%)	2 (11%)	4 (50%)
Pressure image/map		17 (22%)	0 (0%)	16 (33%)	1 (5.3%)	0 (0%)
Vital sign data		8 (10%)	0 (0%)	0 (0%)	4 (21%)	4 (50%)
Input data pre-processing	78					
No		7 (9.0%)	0 (0%)	7 (15%)	0 (0%)	0 (0%)
Yes		70 (90%)	3 (100%)	41 (85%)	19 (100%)	7 (88%)
(Missing)		1 (1.3%)	0 (0%)	0 (0%)	0 (0%)	1 (13%)
ML category	78					
Deep learning		29 (37%)	2 (67%)	22 (46%)	3 (16%)	2 (25%)
Shallow		28 (36%)	1 (33%)	14 (29%)	10 (53%)	3 (38%)
Shallow learning		11 (14%)	0 (0%)	7 (15%)	2 (11%)	2 (25%)
Shallow; Deep learning		10 (13%)	0 (0%)	5 (10%)	4 (21%)	1 (13%)
Experiment_duration	78					
Long (> 1 day)		3 (3.8%)	0 (0%)	0 (0%)	3 (16%)	0 (0%)
Long (> 1 week)		3 (3.8%)	1 (33%)	0 (0%)	1 (5.3%)	1 (13%)
Medium (1 hour - 1 day)		14 (18%)	0 (0%)	5 (10%)	8 (42%)	1 (13%)
Short (< 1 hour)		25 (32%)	2 (67%)	19 (40%)	1 (5.3%)	3 (38%)
Missing		33 (42%)	0 (0%)	24 (50%)	6 (32%)	3 (38%)

¹n (%)

*Other: sleep data, movement data; spectral features & spectrograms.

Table S3. Characteristics of the study considering smart beds

Author, year	Sens or type	N of load cells	Array sensor dimension	Bed sensor placeme nt	N positions	List of positions	Pr on e po si ti on	Su pin e po si ti on	Lat era l po si ti on	Exp eri men t dur atio n
Research article										
Albukhari , 2019 [1]	Load cells	1		In the bed structure	4	Supine; prone; left lateral; right lateral	Yes	Yes	Yes	0.5 - 1.5 hou rs
Alinia, 2020 [2]					11	Walking; sitting; standing; lying supine; lying prone; lying on the left side; kneeling; crawling; lying on the right side	Yes	Yes	Yes	> days
Arora, 2020 [3]	Press ure senso rs	72	72	Outside the mattress						> mon ths
Azimi, 2020 [4]	Load cells	5		Under bed						
Austin, 2012 [5]	Multi ple senso rs	30	Not specified in terms of size, but there are 30 sensing areas.	Embedd ed into a mattress	3	Lying, Sitting on the bed, Sitting on the edge of the bed	No	Yes	No	12 wee ks
Bai, 2023 [6]	Load cells	392	40 cm x 80 cm	Under the mattress Outside the mattress and the bed structure	4	Supine; prone; left lateral; right lateral	Yes	Yes	Yes	15 seco nds
Breuss, 2024 [7]	Emfi senso r									0.5 - 1.5 hou rs

Author, year	Sens or type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Pr on e po si ti on	Su pin e po si ti on	Lat era l po si ti on	Exp eri men t dur atio n
Casas, 2019 [9]	Load cells	200	200	Embedd ed into a mattress	5	Random horizontal positions; fixed horizontal positions; rotation of joints; body stretching; simulated seizures	No	Yes	Yes	< 0.5 hou r
Chica, 2012 [10]	Arra y of press ure senso rs	1664	1664	Embedd ed into a mattress	5	Sit up; lean back; lean right; lean left; rest position	No	Yes	Yes	< 0.5 hou r
Cho, 2019 [11]				Embedd ed into a mattress						1 nigh t - > days
Costello, 2021 [12]	Arra y of press ure senso rs (preproc essing 2048)	200;	2048	Embedd ed into a mattress	10	Supine; right; left; supine wide; supine straight; supine raised; supine right raised; supine left raised; right fetus; left fetus	No	Yes	Yes	< 0.5 hou r
Davoodni a, 2022 [13]	Arra y of press ure senso rs	2048	2048	Embedd ed into a mattress	17	Mix of standard postures and further sub-postures	No	Yes	Yes	
Diao, 2021 [14]	Arra y of press ure senso rs	1024	1024	Embedd ed into a mattress	8	Supine; prone; right; left	Ye s	Yes	Yes	< 0.5 hou r

Author, year	Sensor type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Prone position	Supine position	Lateral position	Experiment duration
Duvall, 2019 [15]	Load cells	4		Outside the mattress and the bed structure	4	Roll; turn in place; extremity movements; assisted turn	No	No	No	<0.5 hours
Fonseca, 2023 [16]	Piezoelectric sensors		27x64 matrix	In the bed structure	28	Supine; prone; left lateral; right lateral	No	No	Yes	
Gabison, 2022 [17]	Load cells	4		In the bed structure	3	Left-side lying, Supine, Right-side lying	No	No	Yes	8-10 hours
Garcia-Molina, 2024 [18]	Temperature sensors	5	0.25 inches below the surface, spacing 14–16.8 cm between sensors	Embedded into a mattress						16 nights
Gargees, 2019 [19]	Load cells	4		In the bed structure	4	Supine; prone; left lateral; right lateral	Yes	Yes	Yes	<0.5 hours
Hagihara, 2021 [20]	Array of pressure sensors	1600	1600	Outside the mattress and the bed structure	16	Prone; long sitting; edge sitting; supine position to right lateral position; right lateral position to supine position; supine position to left lateral position; left lateral position to supine position; right lateral position to prone position; prone position to right lateral position; left lateral position to prone position; prone position to left lateral position; supine position to long sitting; long sitting to edge sitting	Yes	Yes	Yes	<0.5 hours

Author, year	Sens or type	N of load cells	Array sensor dimension	Bed sensor placeme nt	N positions	List of positions	Pr on e po siti on	Su pin e po siti on	Lat era l po siti on	Exp eri men t dur atio n
Hsiao, 2015 [21]	Arra y of press ure senso rs		15	Outside the mattress and the bed structure	3	Right lateral decubitus; left lateral decubitus; supine	No	Yes	Yes	
Hu, 2021 [22]	Arra y of press ure senso rs	1024	1024	Outside the mattress and the bed structure	6	Right yearner; left yearner; left foetus; right foetus; log; supine	No	Yes	Yes	0.5 - 1.5 hou rs
Hu, 2024 [23]	Piezo electr ic senso rs	32	58 cm × 28 cm	Outside the mattress	3	Supine, Right Lateral, Left Lateral	No	Yes	Yes	4.5 - 7 hou rs
Jung, 2022 [24]	Load cells	4		Embedd ed into a mattress	4	Supine; right lateral; left lateral; seated posture	No	Yes	Yes	< 0.5 hou r
Kawakam i, 2017 [25]	Load cells	4		In the bed structure						1 nigh t - > days
Kusmakar , 2021 [26]										1 nigh t - > days
Kuwahara & Wada, 2017 [27]	Arra y of press	3560	3560	Outside the mattress	9	Foetus left; foetus left; log right; log left; yearner right; yearner left; soldier; starfish; freefall	Ye s	Yes	Yes	

Author, year	Sensor type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Prone position	Supine position	Lateral position	Experiment duration
Liu, 2021 [28]	Load cells	4		Outside the mattress	17	Reclining position; prone position; left side of the body; right side of the body; reclining near the right bed edge; reclining near the left bed edge; move randomly; flounce legs; coughs; deep breaths; choke (gasp); speak; sit up on the bed centre; sit on the bed edge; rapid shallow breaths; body tremor; leg movements	Yes	No	Yes	0.5 - 1.5 hours
Manners, 2024 [29]	Other			Under the mattress						8 days
Matar, 2020 [30]	Array of pressure sensors	1728	1728	Outside the mattress and the bed structure	4	Prone; supine; left; right	Yes	Yes	Yes	< 0.5 hours
Monroy, 2020 [31]					6	Supine; left-side; right-side; Fowler's; supine with bent right leg; supine with bent left leg	No	Yes	Yes	0.5 - 1.5 hours
Mosquera-Lopez, 2019 [32]	Array of pressure sensors	16	16	Outside the mattress and the bed structure						1 night -> days
Pornpreedawan, 2022 [33]	Multiple pressure sensors, 6 ultrason	6		Multiple placements	6	Supine, Left Lateral, Right Lateral, Sitting, Left Fall, Right Fall	No	Yes	Yes	1 minute

Author, year	Sens or type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Pr on e po si ti on	Su pin e po si ti on	Lat era l po si ti on	Exp eri men t dur atio n
		ic sensors								
Pupic, 2022 [34]	Load cells	4		Outside the mattress and the bed structure	3	Left-side lying; right-side lying; supine	No	Yes	Yes	
Raschella, 2022 [54]										1 nigh t - > days
Rosales, 2017 [35]	Hydr aulic bed senso r	4		In the bed structure						> mon ths
Stern, 2024 [36]	Load cells	1056		In the bed structure	17	Supine, Prone, Left Lateral, Right Lateral, Sitting at edge	Yes	Yes	Yes	1 min ute
Tandon, 2024 [37]	Load cells			Under the mattress		Multiple positions, including supine, left, and right lateral	No	Yes	Yes	
Tapwal, 2023 [38]	Load cells	2		Embedd ed into a mattress	2 categories (comforta ble and uncomfor table)	Comfortable and uncomfortable postures based on pressure variations	No	No	No	

Author, year	Sensor type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Prone position	Supine position	Lateral position	Experimental duration
Walsh, 2017 [39]	Array of pressure sensors	24	24	Embedded into a mattress						1 night - > days
Waltisberg, 2017 [40]	Array of pressure sensors			In the bed structure						1 night - > days
Willemsen, 2012 [41]	Other			In the bed structure						1 night - > days
Conference paper										
Austin, 2012 [5]	Load cells	5		Outside the mattress						
Bajkowski, 2023 [42]	Hydraulic bed sensor	4		Under the mattress						> 24 hours
Belay, 2022 [43]	Other			In the bed structure	2	Supine; prone	Yes	Yes	No	
Breuss, 2023 [44]	Other		50x80 cm silicone sensor array	Under the mattress	4	Supine; prone; left lateral; right lateral	Yes	Yes	Yes	10 minutes

Author, year	Sens or type	N of load cells	Array sensor dimension	Bed sensor placeme nt	N positions	List of positions	Pr on po siti on	Su pin e po siti on	Lat era l po siti on	Exp eri men t dur atio n
Channa, 2020 [45]	Arra y of press ure senso rs		2048	Embedd ed into a mattress	5	Supine; left foetus; right foetus; left yearner; right yearner	No	Yes	Yes	
Davoodnia, 2019 [46]	Arra y of press ure senso rs		2048	Embedd ed into a mattress	17	Mix of standard postures and additioal uncommon postures	No	Yes	Yes	
Duan, 2021 [47]	Arra y of press ure senso rs		1600	Embedd ed into a mattress	9	Supine; prone; left lateral; right lateral; left frizzy; right frizzy; half up position; left edge; right edge	Yes	Yes	Yes	
Enayati, 2018 [48]	Load cells	4		In the bed structure	4	Supine; prone; left lateral; right lateral	Yes	Yes	Yes	< 0.5 hour
Heydarzadeh, 2016 [49]	Arra y of press ure senso rs		2048	Embedd ed into a mattress	5	Right foetus; right yearner; supine; left yearner; left foetus	No	Yes	Yes	
Husák, 2021 [50]	Load cells		330	Embedd ed into a mattress	4	Supine; prone; left; right	Yes	Yes	Yes	

Author, year	Sensor type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Prone position	Supine position	Lateral position	Experimental duration
Ibrahim, 2024 [51]	Press ure sensors			Under the mattress	4	Supine; prone; left lateral; right lateral	Yes	Yes	Yes	
Lei, 2024 [52]	Load cells	4		In the bed structure	6	Turning over to left; turning over to right; sitting up; lying down; stretching out for something; exiting from the bed	No	Yes	Yes	
Madokoro, 2014 [54]	Load cells			Multiple placements	7	Face-up sleeping; right sleeping; left sleeping; longitudinal sitting; lateral sitting; terminal sitting; left the bed	No	Yes	Yes	< 0.5 hours
Matthies, 2021 [55]	Multiple sensors	4		Outside the mattress and the bed structure	5	Supine; prone; lateral left; lateral right; sitting	Yes	Yes	Yes	< 0.5 hours
Mendez, 2010 [56]	Load cells	6		Embedded into a mattress						
Metsis, 2011 [57]	Array of pressure sensors		1024	Embedded into a mattress						< 0.5 hours
Migliorini, 2010 [58]	Emfi sensor			Embedded into a mattress						

Author, year	Sensor type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Prone position	Supine position	Lateral position	Experimental duration
Moon, 2023 [59]	Load cells	28	7x4 grid of pressure sensors	In the bed structure	4	Supine, left lateral, right lateral, and head elevation	No	Yes	Yes	2 hours
Mukai, 2014 [60]	Load cells		256	Outside the mattress	4	Supine; prone; right lateral; left lateral	Yes	Yes	Yes	
Oboe Kubota, 2014 [61]	Multiple sensors	2		Outside the mattress and the bed structure	5	Sleep; rollover; get-up; none; walk	No	Yes	No	
Perez-Macias, 2017 [62]	Emfi sensor			Embedded into a mattress						
Pouyan, 2014 [63]	Array of pressure sensors		2048	Embedded into a mattress						
Pouyan, 2015 [64]	Array of pressure sensors		1728	Outside the mattress and the bed structure						1 night -> days
Pouyan, 2017 [65]	Array of pressure		2048	Embedded into a mattress	17	Mix of standard postures and additional states	No	Yes	Yes	

Author, year	Sensor type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Prone position	Supine position	Lateral position	Experimental duration
Rangarajan, 2022 [66]	sensors				3	Supine; left lateral; right lateral	No	Yes	Yes	2 minutes
Russo, 2021 [67]	Array of pressure sensors		2048	Embedded into a mattress	17	Supine; right; left	No	Yes	Yes	
Sano & Picard, 2014 [68]										
Sawada, 2022 [69]	Other	6 RFID		In the bed structure	7	Supine, Right Lateral, Left Lateral, Sitting, Lateral Exit, Longitudinal Exit, Terminal Sitting (edge of bed)	No	Yes	Yes	1 minute
Soleimani & Pesch, 2023 [70]	Array of pressure sensors		32" x 64"	Outside the mattress	3	Supine, Left Lateral, Right Lateral	No	Yes	Yes	2 minutes
Vázquez-Santacruz & Gamboa-Zúñiga, 2016 [71]	Array of pressure sensors		448	Embedded into a mattress	4	Right lateral decubitus; supine; left lateral decubitus; prone	Yes	Yes	Yes	

Author, year	Sens or type	N of load cells	Array sensor dimension	Bed sensor placement	N positions	List of positions	Pr on e po si ti on	Su pin e po si ti on	Lat era l po si ti on	Exp eri men t dur atio n
Vyas, 2021 [72]	Hydraulic bed sensor	4		In the bed structure						
Wai, 2009 [73]	Array of pressure sensors			Embedded into a mattress	9	Free faller; soldier; starfish; left foetus; right foetus; left log; right log; left yearner; right yearner	Yes	Yes	Yes	
Wu, 2023 [74]	Load cells	56 × 40 sensing units	1.96 × 0.96 m ²	In the bed structure	23	Supine; prone; left lateral; right lateral	Yes	Yes	Yes	
Yoon, 2024 [75]	Load cells	28 sensors (7x4 array)	33.5 cm × 5.5 cm for each cell	In the bed structure	4	Supine, Left Lateral, Right Lateral, Head Elevated	No	Yes	Yes	2 hours
Youngkong, 2021 [76]	Array of pressure sensors		144	Outside the mattress and the bed structure	6	Supine; lateral; prone. Standing; sitting; lying	Yes	Yes	Yes	< 0.5 hours
Yousefi, 2011 [77]	Array of pressure sensors			In the bed structure						

Abbreviations: Aops = array of pressure sensors

Table S4. Characteristics of the machine learning models

Author, year	Input data	Outcome	Type of pre-processing	Model	Best model (of Article)	Accuracy (best for Model)	F1	Sensitivity	Specificity
Shallow learning									
Albukhari, 2019 [1]	Pressure data	Vital signs	Feature extraction; sigl manipulation	Unsupervised	Hierarchical clustering	83.9			
Austin, 2012 [5]	Pressure data	Sleep	Feature extraction; SMOTE; sigls manipulation	DT; LDA NB;SVM	SVM			0.81	0.81
Azimi, 2020 [4]	Pressure data	Sleep	Feature extraction; SMOTE; sigls manipulation	DT;LD;NB;SVM	SVM		66.7-87.6	96-100	
Bajkowski, 2023 [42]	Clustering results for cohort discovery	Clustering results for cohort discovery	Sigl decomposition into respiration, cardiovascular, and movement features	Fuzzy C-Means, Gustafson-Kessel FCM					
Bruser, 2013 [8]	vital sign data	Vital signs	Smote; sigl manipulation; feature extraction	Bat;bot;LD;NB;QD;SVM	RF	95.8			
Channa, 2020 [45]	Pressure data	In-bed position estimation	No	DT;KNN;SVM	KNN	> 98			
Duan, 2021 [47]	Pressure data	In-bed pose estimation	PCA	DT;KNN;SVM	SVM	96.8			
Duvall, 2019 [15]	pressure data	in-bed position estimation	PCA	KNN		> 94.8			
Fonseca, 2023 [16]	Posture classification	In-bed position estimation	Normalization, cross-validation	KNN;SVM;DT;RF	MLP	99			
Gabison, 2022 [17]	Participant positions in bed (left-side lying, supine, right-side lying)	In-bed position estimation	Feature extraction from load cell data	Xgboost, GBC, LGB	Xgboost	98			
Garcia-Molina, 2024 [18]	Skin temperature estimation (distal skin temperature)	Skin temperature estimation (distal skin temperature)	Sigl smoothing (LOWESS), subsampling	GBT, RF	RF	87			

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Hagihara, 2021 [20]	Pressure image/map	In-bed position estimation	Baum-Welch algorithm of HMM	SVM;RF	RF	81.3-92			
Hsiao, 2015 [21]	Pressure data; respiration; body movement	In-bed position estimation	Sigls manipulation	FIS	FIS	92			
Ibrahim, 2024 [51]	Body movement detection, posture detection, fall detection	in-bed position estimation	feature extraction	DT	DT	98.70	98.50	98.90	
Jung, 2022 [24]	Vital sign data	Vital signs	Signals manipulation	XGB	XGB				
Kusmakar, 2021 [26]	Acceleration data; movement counts	Sleep	Feature extraction; signal manipulation	RF, SVM	RF	80	76	82	
Manners, 2024 [29]	Vigilance performance (reaction times, lapses, speed)	Vigilance performance (reaction times, lapses, speed)		Extra-trees, linear, elastic net, RF, SVM, gboosting	Extra-trees classifier	84	84		
Matthies, 2021 [55]	Pressure data	In-bed position estimation	No	RF		85			
Metsis, 2011 [57]	Pressure image/map	In-bed pose estimation	PCA	KNN	KNN	90.40-90.81			
Migliorini, 2010 [58]	Vital sign data	Sleep	Feature extraction; sigl manipulation	QD;LDA	QD	76.81			
Monroy, 2020	Acceleration data	Multiple output data	Sigls manipulation	Fuzzy ;KNN;SVM;DT	SVM				
Mosquera-Lopez, 2019 [32]	Pressure data; movement sigls	Sleep	Sigl manipulation; FTT	DT;KNN;SVM	DT	74.3	88.9	76.5	
Mukai, 2014 [60]	Pressure data	In-bed position estimation	Sigl manipulation	Adaboost					
Pornpreedawan, 2022 [33]	Movement classification (lying, sitting, falling)	In-bed position estimation	Data thresholds applied	Finite State Machine (FSM)	FSM	88.67	77.33	100	
Pouyan, 2014 [63]	Pressure image/map	Bedsore	Sigl manipulation; feature extraction	C4.5;KNN;NB;PART	KNN	88-96.1	80.1		
Pouyan, 2015 [64]	Pressure image/map	Sleep	Feature extraction; sigl manipulation	RF	RF	88	85.7-92.2	90.3-95.8	90.3-95.8
Rangarajan, 2022 [66]	Patient position classification and	In-bed position estimation	Isolation Forest model for data cleaning	LR	LR	95-99			

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	pressure redistribution							
Raschella, 2022 [54]	Acceleration data	Sleep	PCA	SVM	SVM	92.9 ± 8.16	94.9±7.4	92.7±13.8
Rosales, 2017 [35]	Pressure data	Vital signs	Feature extraction; sigl manipulation	KMCA;FCM	KMCA			
Sano & Picard, 2014 [68]	Multiple input data	Sleep	Feature extraction; sigl manipulation	SVM; KNN	SVM	67-85		
Sawada, 2022 [69]	Posture classification	In-bed position estimation	Averaging RSSI data over 1 second	Linear SVC, SGD, KNN		96.7		
Soleimani & Pesch, 2023 [70]	Posture detection and at-risk area identification for pressure ulcers	In-bed position estimation	Segmentation, histogram equalization, Gaussian filtering, Principal Component Alysis (PCA)	SVM		99.2		
Tapwal, 2023 [38]	Categorization of patient condition (comfortable or uncomfortable)	In-bed position estimation	K-means clustering	K-means clustering	K-means clustering	99		
Vázquez-Santacruz & Gamboa-Zúñiga, 2016 [71]	Pressure image/map	In-bed position estimation	Feature extraction	SVM	SVM	99.01		
Wai, 2009 [73]	Pressure data	In-bed position estimation	PCA	SVM		73.90-95.30		
Waltisberg, 2017 [40]	Pressure data	Sleep	PCA; feature extraction; sigl manipulation	NB	NB	71.9		
Willemen, 2012 [41]	Movement data	Sleep	Sigls manipulation	SVM	SVM	94	68.38	83.55
Yoon, 2024 [75]	Posture classification	In-bed position estimation	Data imputation, normalization, resampling with SMOTE	DT, RF, AB		93		
Yousefi, 2011 [77]	Pressure image/map; vital sign data; other	Bedsore	PCA	SVM;KNN	KNN	97.7		
				Deep Learning				
Arora, 2020 [3]	Sleep data	Sleep	SMOTE	CNN, FFANN	CNN	<97.30	73-98	
Bai, 2023 [6]	Sleep quality, bed-exit intention, in-bed postures	Multiple output data	Machine learning models used for identifying	Multilayer Perceptron	MLP	97.4	69.2	

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postures and patterns							
Belay, 2022 [43]	Classification of on-bed movement patterns (prone and supine positions)	In-bed position estimation	Sigl processing and feature extraction	RF, MLP	MLP	99.83	
Breuss, 2023 [44]	Sleep position classification	In-bed position estimation	Image thresholding and grayscale conversion			91.2	
Breuss, 2024 [7]	Sleep position classification	In-bed position estimation	Image normalization			95-82.7	95
Casas, 2019 [9]	Pressure data	In-bed position estimation	PCA	CNN	CNN		
Costello, 2021 [12]	Pressure data	Multiple output data	Sigls manipulation	ConvLSTM	CNN	98.61	98.80
Davoodnia, 2022 [13]	Pressure image/map	In-bed position estimation	Sigls manipulation	FFANN	Polishnetu+Re-trained openpose	95.0	
Diao, 2021 [14]	Pressure image/map	In-bed position estimation	Sigls manipulation	CNN	Deep residual networks	<95.08	
Enayati, 2018 [48]	Pressure data	In-bed position estimation	PCA; principal component alysis; feature extraction	FFANN	FFANN	> 99	
Gargees, 2019 [19]	Vital sign data	Sleep	Sigls manipulation	AE, CNN	Autoencoders (or Diabolo network)	84-95.3	
Heydarzadeh, 2016 [49]	Pressure image/map	In-bed position estimation	Sigl manipulation; feature extraction			98	
Hu, 2021 [22]	Pressure image/map	In-bed position estimation	No	CNN	CNN	91	
Hu, 2024 [23]	Sleep posture classification	In-bed position estimation	Sigl decomposition and artifact identification			93.02	92.29 91.96
Husak, 2021 [50]	Pressure data	In-bed position estimation	Sigls manipulation	ANN	ANN		
Kawakami, 2017 [25]	Pressure data	In-bed pose estimation	No	FFANN	Chainer	>95	
Kuwahara & Wada, 2017 [27]	Pressure image/map	In-bed position estimation	Sigls manipulation	AE, CNN	CNN	92	

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Lei, 2024 [52]	3D body mesh	3D body mesh	Image preprocessing for dataset				
Luo, 2018 [53]	Pressure data	In-bed position estimation	Feature extraction; sigl manipulation	AE;FFANN	RVFLNN	98	
Madokoro, 2014 [54]	Acceleration data; other	In-bed position estimation	Feature extraction	FFANN	CPN	75.5	
Matar, 2020 [30]	Pressure image/map	In-bed position estimation	Hog; LBP; PCA	FFANN	FFANN	97.9	
Moon, 2023 [59]	Posture classification for bedridden patients	In-bed position estimation	Data imputation and feature extraction	RF, DT, AB, MLP		96.29	99
Oboe Kubota, 2014 [61]	Vibration; pressure data	In-bed position estimation	No	FFANN	FSNN	<80	
Pouyan, 2017 [65]	Pressure image/map	In-bed position estimation	No	FFANN	Deep belief network	82.3	
Russo, 2021 [67]	Pressure data	In-bed position estimation	Feature extraction	CNN	CNN	96.77	
Stern, 2024 [36]	Body posture classification	In-bed position estimation	Numerical pressure values converted to pressure distribution images			92.07	85.37
Tandon, 2024 [37]	3D body mesh	In-bed position estimation	Alignment of depth and pressure images	Pointnet, resnet18, MLP			
Vyas, 2021 [72]	Vital sign data	Sleep	Sigl manipulation	CNN;RNN	LSMT	75.6	
Wu, 2023 [74]		Body weight estimation	Data augmentation (flip, rotation, shift), smoothing, zero-padding				
Both Shallow and Deep Learning							
Alinia, 2020 [2]	Acceleration data	In-bed position estimation	Sigls manipulation	RF, RNN	Adalstm	698.9	95.2-97.8
Chica, 2012 [10]	Pressure image/map	In-bed position estimation	PCA	C4.5;KNN;NB;oneR	MLP	84.7	
Cho, 2019 [11]	Acceleration data	Sleep	Sigl manipulation; feature extraction	LD; NB; RF	CNN + LSTM	82.78	

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Davoodnia, 2019 [46]	Pressure image/map	In-bed pose estimation	Signals manipulation	KNN;SVM; Bat	FNN	100			
Liu, 2021 [28]	Pressure data	Vital signs	PCA for SVM and MLP; normalised time series for hybrid RNN	SVM, RNN, FFANN	Hybrid RNN				
Mendez, 2010 [56]	Movement data	Sleep	Feature extraction; sigl manipulation	MLT, KNN	KNN	71.95			
Perez-macias, 2017 [62]	Spectral features & spectrograms	Sleep	Feature extraction; signal manipulation	SVM	CNN	94	93	92	96
Pupic, 2022 [34]	Pressure data	In-bed position estimation	Feature extraction; sigl manipulation	ADA;GBC;LGB;XGB	XGB	84.03			
Walsh, 2017 [39]	Pressure data; vital sign data	Sleep	Feature extraction	LDA;QDA;KNN;SVM	MLP	74.3			
Youngkong, 2021 [76]	Pressure image/map	In-bed position estimation	No	RF;DT;BAG	RF	99.9			

Abbreviations models: AE = Autoencoder, ANN = Artificial Neural Network, BAG = Bootstrap Aggregating or Bagging, Bat = Bagged Tree, BoT = Boosted Tree, CNN = Convolutional Neural Network, DL = Deep Learning, DT = decision tree, FFANN = Feed Forward Artificial Neural Network, Fuzzy = Fuzzy C-means Clustering; Knowledge-Based Fuzzy; Fuzzy Inferenced Rules; Fuzzy Theory, GBC = Gradient Boosting Classifier, KMCA = K Mean Clustering Approach, KNN = K-Nearest Neighbor, LD = Linear Discriminant (Analysis), LGB = Light Gradient Boosting, NB = Naïve Bayes, SL = Shallow Learning (MLT - E/Ensamles), PART = Partial Decision Tree, QD = Quadratic Discriminant (Analysis), RF = random forest, RNN = Recurrent Neural Network, SVM = Support Vector Machine, TL = transfer learning, XGB = XGBoost.

Table S5. Quality Assessment of Studies Using the PROBAST Tool for Risk of Bias Evaluation

Study ID	Predictors	Participants	Outcome	Analysis	Overall
Albukhari, 2019 [1]	Low	Unclear	Low	Low	Unclear
Alinia, 2020 [2]	Low	Low	High	Low	High
Arora, 2020 [3]	Low	Low	High	Low	High
Austin, 2012 [5]	Low	Low	Low	Unclear	Unclear
Azimi, 2020 [4]	Low	Unclear	Low	Unclear	Unclear
Bai, 2023 [6]	Low	Low	Low	Unclear	Unclear
Bajkowski, 2023 [42]	Low	Low	Low	High	High
Belay, 2022 [43]	Low	Unclear	High	Low	High
Breuss, 2023 [44]	Low	NA	Low	Low	Low
Breuss, 2024 [7]	Low	Low	High	Low	High
Bruser, 2013 [8]	Low	Low	Low	Low	Low
Casas, 2019 [9]	Low	Unclear	Low	Low	Unclear
Channa, 2020 [45]	Low	Low	Low	Low	Low
Chica, 2012 [10]	Unclear	Low	Low	Low	Unclear
Cho, 2019 [11]	Low	Unclear	High	Low	Unclear
Costello, 2021 [12]	Low	Low	Low	Low	Low
Davoodnia, 2019 [46]	Low	Low	Low	Low	Unclear
Davoodnia, 2022 [13]	Low	Low	Low	Unclear	Unclear
Diao, 2021 [14]	Low	Low	Low	Unclear	Unclear
Duan, 2021 [47]	Low	Unclear	Low	Unclear	Unclear
Duvall, 2019 [15]	Low	Unclear	Low	Unclear	Unclear
Enayati, 2018 [48]	Low	Low	Low	Unclear	Unclear
Fonseca, 2023 [16]	Unclear	Unclear	Low	Unclear	Unclear
Gabison, 2022 [17]	Low	Unclear	Unclear	Unclear	Unclear
Garcia-Molina, 2024 [18]	Low	Low	Low	High	High
Gargees, 2019 [19]	Low	Low	Low	Unclear	Unclear
Hagihara, 2021 [20]	Low	Low	Low	Unclear	Unclear
Heydarzadeh, 2016 [49]	Low	Unclear	Low	Unclear	Unclear
Hsiao, 2015	Low	Low	Low	Low	Low
Hu, 2021 [22]	Low	NA	Low	Low	High
Hu, 2024 [23]	Low	Low	Low	Unclear	Unclear
Husák, 2021 [50]	Unclear	Low	Low	High	High
Ibrahim, 2024 [51]	Low	Low	High	Low	High
Jung, 2022 [24]	Low	Low	Low	Low	Low
Kawakami, 2017 [25]	Unclear	High	Low	Unclear	High
Kusmakar, 2021 [26]	Low	Low	High	Unclear	High

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Kuwahara & Wada, 2017 [27]	Low	Unclear	Low	Unclear	Unclear
Lei, 2024 [52]	Low	Low	High	High	High
Liu, 2021 [28]	Low	High	Low	High	High
Luo, 2018 [53]	Low	Unclear	Low	Unclear	Unclear
Madokoro, 2014 [54]	Low	Unclear	Unclear	Unclear	Unclear
Manners, 2024 [29]	Low	Low	Low	Low	Low
Matar, 2020 [30]	Low	Low	Low	Unclear	Unclear
Matthies, 2021 [55]	Low	Low	Low	Unclear	Unclear
Mendez, 2010 [56]	Low	Low	Low	Unclear	Unclear
Metsis, 2011 [57]	Low	High	Low	Unclear	High
Migliorini, 2010 [58]	Low	Low	Unclear	Unclear	Unclear
Monroy, 2020 [31]	Low	Low	High	Unclear	High
Moon, 2023 [59]	Low	Unclear	Low	Low	Unclear
Mosquera-Lopez, 2019 [32]	Unclear	Low	Low	Unclear	Unclear
Mukai, 2014 [60]	Low	Low	Low	Unclear	Low
Oboe Kubota, 2014 [61]	Low	Low	Low	Unclear	Unclear
Perez-Macias, 2017 [62]	Low	Low	High	Low	High
Pornpreedawan, 2022 [33]	Low	Unclear	Low	Unclear	Unclear
Pouyan, 2014 [63]	Low	Low	Low	Unclear	Unclear
Pouyan, 2015 [64]	Low	Low	Low	Low	Low
Pouyan, 2017 [65]	Low	Low	Low	Unclear	Unclear
Pupic, 2022 [34]	Low	Low	Low	Unclear	Unclear
Rangarajan, 2022 [66]	Low	Low	Low	Low	Low
Raschella, 2022 [54]	Unclear	Low	High	Low	High
Rosales, 2017 [35]	Low	High	Low	High	High
Russo, 2021 [67]	Low	Low	Low	Unclear	Unclear
Sano & Picard, 2014 [68]	Low	Low	High	Unclear	Unclear
Sawada, 2022 [69]	Low	Low	Low	Unclear	Unclear
Soleimani & Pesch, 2023 [70]	Low	Low	Low	Low	Low
Stern, 2024 [36]	Low	Unclear	Low	Low	Unclear
Tandon, 2024 [37]	Low	High	High	High	High
Tapwal, 2023 [38]	Low	Low	Low	Unclear	Unclear
Vázquez-Santacruz & Gamboa-Zúñiga, 2016 [71]	Low	High	Low	Unclear	High
Vyas, 2021 [72]	Low	NA	Low	Unclear	High
Wai, 2009 [73]	Low	High	High	Unclear	High
Walsh, 2017 [39]	Low	Low	Low	Unclear	Unclear
Waltisberg, 2017 [40]	Unclear	Unclear	High	Unclear	High
Willemen, 2012 [41]	Low	Unclear	Low	Low	Unclear

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Wu, 2023 [74]	Low	Unclear	Low	High	Unclear
Yoon, 2024 [75]	Low	Low	Low	Low	Low
Youngkong, 2021 [76]	Low	Low	Low	Low	Low
Yousefi, 2011 [77]	Low	NA	High	Unclear	High

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