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Cardiometabolic risk factors and mental health status among truck drivers: a systematic review

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ABSTRACT

Objective This study aimed to systematically review and summarise the literature on cardiometabolic risk factors, lifestyle health behaviours and mental health status of truck drivers globally to ascertain the scale of these health concerns.

Design Systematic review reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Data sources PubMed, Scopus, PsycINFO and Web of Science were searched in January 2019 and updated in January 2020, from the date of inception to 16 January 2020.

Eligibility criteria for selecting studies Papers were included if they (1) reported independent data on truck drivers, (2) included quantitative data on outcomes related to cardiometabolic markers of health, mental health and/or health behaviours, (3) were written in English and (4) were published in a peer-reviewed journal. Grey literature was ineligible for this review.

Data extraction and synthesis One reviewer independently extracted data and assessed methodological quality using a checklist based on the National Heart, Lung and Blood Institute Quality Assessment tool. 20% were independently assessed for eligibility and quality by a second reviewer. Due to heterogeneity of the outcomes, results were narratively presented.

Results 3601 titles and abstracts were screened. Seventy-three studies met the inclusion criteria. Truck driving is associated with enforced sedentarism, long and irregular working hours, lack of healthy foods, social isolation and chronic time pressures. Strong evidence was observed for truck drivers to generally exhibit poor cardiometabolic risk profiles including overweight and obesity, hypertension, hypercholesterolaemia, high blood glucose, poor mental health and cigarette smoking.

Conclusions Improving truck driver health is vital for the longevity of the trucking industry, and for the safety of all road users. The workplace plays a vital role in truck driver health; policies, regulations and procedures are required to address this health crisis.

PROSPERO registration number CRD42019124499.

Strengths and limitations of this study

- This review encompasses a comprehensive range of cardiometabolic markers of health and lifestyle factors that provides a rich description of the overarching health of truck drivers globally.
- This is the first systematic review to address the gap in the evidence base by examining the cardiometabolic health of truck drivers globally, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.
- Meta-analysis was not possible due to heterogeneity in methods and descriptive presentation of results.
- This study assessed the risk of bias of each included paper including the informativeness and methodological quality.
- Findings could be impacted by a 'healthy worker effect', in that truck drivers in most countries must undergo and pass a medical assessment to maintain their licence, drivers who are at-risk may either choose not to enrol in studies or fail the medical examination and would therefore be excluded from the study samples, which could potentially bias the overall health profile of participants included within the reviewed studies.

INTRODUCTION

Truck driving encompasses an abundance of integral, interlinking health risk factors that create barriers to the adoption of healthy lifestyle behaviours. These include long hours of enforced sedentarism, reducing opportunities for physical activity, limited availability of healthy food, irregular shift patterns and sleep deprivation.[1] The isolated nature of the work results in a lack of peer social modelling and poor mental health.[2] This is exacerbated by intense job demands and low levels of perceived job control, resulting in chronic time pressures compounded by tight delivery schedules and traffic conditions.[3] Truck driving is a male-dominated industry comprising an ageing workforce.[4] These factors are likely associated with the high prevalence of obesity, chronic diseases, mental ill health and reduced life expectancies seen in truck drivers in comparison to other occupational groups.[5–8] The health and well-being of professional truck drivers is of public concern

given their health impacts the safety of all road users.[6] For example, truck drivers with obesity, cardiovascular disease, depression, anxiety or with ≥3 comorbidities have a significantly increased risk of preventable crashes.[9–13]

There is a developing body of evidence relating to the physical and mental health of truck drivers which consist of small-scale independent studies. When efficiently aggregated together, these studies will establish whether the findings are consistent and hence provide greater strength with the ability to establish a better understanding of the international prevalence. This prompts the need for a systematic review and appraisal of data to facilitate health promotion interventions for this underserved occupational group. The objective of this paper was to systematically review the literature regarding the cardiometabolic and mental health profile of truck drivers globally.

METHODS

The review protocol was reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, see online supplemental material 1 and 2).[14]

Search strategy

A literature search for relevant papers was conducted in four electronic bibliographic databases: PubMed, Scopus, PsycINFO and Web of Science. Several synonyms of 'truck driver' were used such as 'HGV' and 'lorry driver', a truck driver in this paper is defined as somebody who earns a living transporting goods over land by operating a heavy goods vehicle, this means that the criteria would accept lorry drivers but reject bus, coach, van, taxi and train drivers. These were combined with a comprehensive list of forty key terms for risk factors, related health outcomes and lifestyle factors/behaviours to locate potentially relevant studies. Keywords were created with guidance from a research librarian to ensure a thorough scope was reached. An example of the search strategy used for PubMed is provided in online supplemental material 3. In addition, manual searches of reference lists of primary studies, reviews and identified articles were conducted. The search strategy was carried out in January 2019 and updated in January 2020.

Patient and public involvement

No patient involved.

Inclusion criteria

To be included in the review, the studies were required to (1) report independent data on truck drivers, (eg, if data were combined with bus drivers then they were excluded), (2) include quantitative data on outcomes related to cardiometabolic markers of health, mental health and/or health behaviours, (3) be written in English and (4) be published in a peer-reviewed journal from the date of inception up to the 16 January 2020. All study designs were considered for inclusion.

Identification of relevant studies

The titles and abstracts of identified articles were simultaneously screened for eligibility by one reviewer (AG), 20% of which were randomly selected and verified by a second reviewer to ensure consistency (Y-LC), which resulted in a 96% agreement rate. If abstracts were not available or provided insufficient information, the entire article was retrieved and screened against the inclusion criteria. Any discrepancies in identification of relevant studies were discussed. If a decision could not be reached then a third reviewer was consulted (NPe).

Data extraction

Data were extracted from all included papers on standardised Excel spreadsheets by one reviewer (AG). Extracted data included: study design, country, sample size, sociodemographic information, measurement methods, main findings, funding source, markers of health (anthropometric measurements, blood pressure, blood profile, mental health) and lifestyle health behaviours (diet, physical activity, addictive behaviours).

Methodological quality assessment

Included studies were evaluated on their methodological quality using a checklist based on the National Heart, Lung and Blood Institute Quality Assessment tool for cross-sectional and cohort studies,[15] though questions were tailored for this review. The questions referred to informativeness (two items) and study methodology (four items). It was scored as positive (+), negative (−) or not reported/applicable (?). The primary author (AG) scored the quality of each article, the second author (Y-LC) independently scored 20%. The results of the scoring were compared, and differences were discussed and rectified with the assistance of a third author (NPe). Papers were deemed good if they met ≥5 criteria, fair if they met 4 and poor if they met ≤3 criteria.

RESULTS

Search and selection

The literature search yielded 3601 potentially relevant papers, of which 95 were included, representing 73 studies (figure 1). Online supplemental material 4 shows the studies which consist of multiple papers. Sample sizes ranged from 12 to 95 567. Study designs included cross-sectional (53 studies, 68 papers), repeated cross-sectional (3 studies, 5 papers), case–control (5 studies/papers), retrospective cohort (4 studies/papers), prospective cohort (6 studies/papers) and interventions (5 studies, 7 papers) table 1. Due to heterogeneity between study methodologies, a qualitative synthesis of the data was deemed most appropriate to draw conclusions about the cardiometabolic and mental health of truck drivers.[16] See online supplemental material 5 for the full summary of included papers.

Quality assessment

A summary of the quality assessment of the included papers is shown in table 2. Individual paper quality

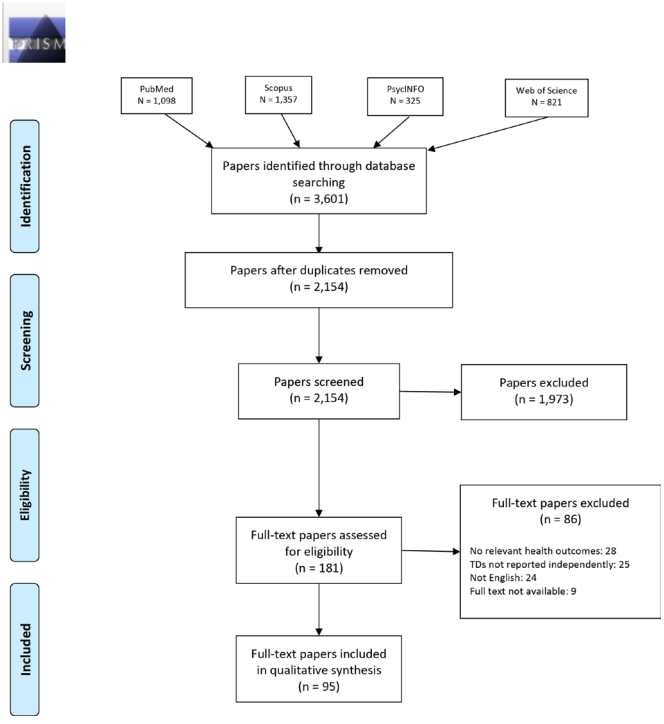

Figure 1 PRISMA flow diagram of literature search and selection of studies in review. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

assessment has been provided in online supplemental material 6.

Demographics

Sixty-five studies included information on sex distribution[2 3 5 9 11–13 17–92] of which, only 15% included <90% males.[11 23 26 30 32 36 41 55 57 64 69] Twenty-eight studies were conducted in North America, 12 in South America, 14 in Asia, 8 in Europe, 8 in Australia and 3 in Africa (table 1). Of the studies which reported average age of participants, the means ranged from 22.8[66] to 56.3 years.[91] Seventy-five per cent of studies reported mean ages over 40 years.[2 5 11–13 17 18 22 25 26 28 30 31 33 35–39 41–44 47–57 59–61 64 65 69–72 74 75 78 79 81–83 85 87–89 91–98] Twenty-four studies reported sample ethnicity,[2 11 25 26 31 33 36–41 44 47 49 50 55 57 60 61 63 64 66 67 73 75 84 89 94 97 98] with all but three including a majority of white participants.[33 66 73] Thirty-five studies described participants' education level,[2 13 19 20 25 27 33 34 36 40 41 43–45 47–50 57 58 63–69 71 73 75 77 83 86 89–91 94 96 97 99] the percentage of those not completing high/secondary school ranged from 11.5%[69] to 96.7%,[27] though the overall trend was towards most participants having a low level of education, with the majority not completing secondary/high school education. Thirty-six studies reported classifications of truck drivers. Twenty-seven of these were long haul (ie, typically drives >250 miles per drop),[9 22 25 27 28 30 33 34 36–40 49–51 53 55 60–65 68 70 73 75 83 85 89 93–95 97 100] two short haul (ie, typically drives <150 miles per drop)[48 54] and six reported a combination of both long and short haul.[17 32 59 69 72 101] Two studies compared day shift and irregular shift truck drivers.[19–21 32]

Markers of health

Anthropometrics

Fifty-three studies reported body mass index (BMI) (table 1), 63.8% objectively measured height and weight, while 36.2% relied on self-reported data. Mean BMI ranged from 22.0[27] to 39.7 kg/m^2.[28] Based on the WHO guidance for BMI thresholds for White European and Asian populations,[102] only two studies reported an average healthy BMI[27 103] within their samples. Twenty-seven studies reported a sample mean BMI within the overweight category;[9 19–24 29 32 40 43 45–48 52–54 58 71–74 80–82 85–89 96 97 99] 23 studies were within the obese category.[2 5 11 12 17 18 25 26 28 30 31 37–39 41 42 44 49–51 55–57 59 69 70 78 79 83 84 94 95 98 100] One study reported obesity was twice as prevalent in a sample of US truck drivers than the US adult population.[89]

Sixteen studies included waist circumferences,[11 17–21 26–28 30 37 38 40–42 47 60 69 73 83 84 87 94 97] with 12 of these reporting average waist circumferences which indicate increased risk of developing adverse health conditions (>102 cm Europids/>90 cm South Asians).[11 17 18 26 28 30 37 38 41 42 47 60 69 83 84 87 94 97 104]

Blood pressure

Nineteen studies included blood pressure measurements,[5 11 18 21 23 26 28 37–39 41 42 47 53 54 60 69 73 79 80 82 83 93 97 98] with average blood pressures ranging from 116/80[23] to 142/87 mmHg.[18] Twenty-nine studies included prevalence of self-reported or objectively measured hypertension,[3 5 11 12 17 25 27 33 34 39–43 46 49 53 61–64 69 70 72 75 78–80 82 86–89 96–98 103] with thresholds ranging from >140/>90 to>165/>95 mmHg, though many studies did not report the hypertension thresholds applied. Hypertension prevalence ranged from 3%[34] to 63%.[17] Two studies found truck drivers with obesity had a higher prevalence of hypertension.[46 88] Seventy-seven per cent of studies[5 11 17 19 27 39–42 49 53 62 63 69 75 79 82 86–88 97 98 103] indicated that the prevalence of hypertension in truck drivers was higher than the global prevalence (26.4%).[105]

Blood profile

Total cholesterol

Twelve studies objectively measured total cholesterol levels.[11 19 21 26 28 37–42 47 49 54 61 69 73 88] Most measurements were in mg/dL, mean readings ranged from 168.2 mg/dL[37] to 202.8 mg/dL,[54] though the latter reading was not fasted. Six studies measured the prevalence of high total cholesterol levels.[19 38–40 49 69 88] Thresholds varied from >190[19] to >240 mg/dL,[88] though the remainder[38–40 69 106] reported high total cholesterol based on the Adult Treatment Panel (ATP) III classification of >200 mg/dL.[107] Of those using the >200 mg/dL threshold, studies reported prevalence of borderline-high total cholesterol as 11.4%,[38 39] 33.0%,[40] 38.8%[69] and 45.8%.[106]

High-Density Lipoprotein (HDL)

Eleven studies reported HDL,[11 19 21 26 28 37–42 47 54 60 61 69 73 83] most measurements were in mg/dL, mean readings ranged from 29.0 mg/dL[28] to 52.5 mg/dL.[54] Forty three per cent of studies (n=7 studies) reported mean HDL level as low

Table 1 Characteristics of the papers (N=95) included in the review, split by sample size, study design, data collection methods, country of study and methodological quality assessment

	Markers of health						Health behaviours		
	BMI	Circumferences (Waist/hip)	Blood Pressure (measured and reported hypertension)	Blood profile (cholesterol)	Blood profile (glucose, diabetes)	Mental health (stress, fatigue, depression, anxiety)	Diet	Physical activity	Addictive behaviours (alcohol, smoking, illicit drugs)
No of studies (N)	n=53 NRP=71	n=16 NRP=23	n=37 NRP=51	n=17 NRP=25	n=30 NRP=43	n=29 NRP=34	n=17 NRP=18	n=25 NRP=30	n=47 NRP=58
Sample size									
1–100 n=20 NRP=23	n=14 NRP=17 (C[17 18]) (I[19–21]) (J[9]) (L[22])[23–32]	n=6 NRP=9 (C[17 18]) (I[19–21])[26–28 30]	n=10 NRP=12 (C[17 18]) (I[19 21])[23 25–28 33 34 93]	n=3 NRP=4 (I[19 21])[26 28]	n=7 NRP=9 (I[19–21])[25–28 33 34]	n=9 NRP=9 (I[21]) (L[22])	n=7 NRP=8 (C[17 18]) (I[20])[26 28 30 32 35]	n=7 NRP=8 (C[17]) (I[19 20]) (L[22])[26 28 30 36]	n=9 NRP=11 (C[18]) (I[19–21])[23 27 32–36]
101–500 n=30 NRP=42	n=23 NRP=31 (A[37–39 94 95]) (D[40]) (E[41 42]) (F[43 96]) (G[2 44]) (H[45 99]) (J[46])(L[47])[48–59 97 100 103]	n=5 NRP=9 (A[37 38 60 94]) (D[40]) (E[41 42]) (L[47])[97]	n=13 NRP=21 (A[37–39 60–62]) (D[40 63]) (E[41 42]) (F[43 96]) (J[46]) (L[47])[3 49 53 54 64 97 103]	n=7 NRP=13 (A[37–39 60–62]) (D[40]) (E[41 42]) (L[47])[49 53 54]	n=12 NRP=19 (A[37–39 60–62]) (D[40]) (E[41 42]) (F[43 96]) (L[47])[3 48 49 53 54 64 97]	n=13 NRP=16 (A[62 94 95]) (D[63]) (F[43 96]) (G[2]) (H[45]) (L[47])[3 58 64–68]	n=8 NRP=8 (E[42]) (F[43]) (L[47])[48 50 53 56 59]	n=14 NRP=16 (A[38 39 62]) (D[40]) (E[42]) (G[44]) (H[99]) (L[47])[48 49 53 55 56 58 59 97 103]	n=20 NRP=26 (A[38 39 62]) (D[40 63]) (E[41 42]) (F[43 96]) (G[2]) (H[45 99]) (J[46]) (L[47])[3 48 49 53 54 56 58 65 67 68 97 103]
501–1000 n=11 NRP=12	n=6 NRP=7 (K[11 69])[70–74]	n=2 NRP=3 (K[11 69])[73]	n=5 NRP=6 (K[11 69])[70 72 73 75]	n=2 NRP=3 (K[11 69])[73]	n=5 NRP=6 (K[11 69])[70 72 73 75]	n=5 NRP=5[13 71 73 75 76 112]	n=1 NRP=1[73]	n=2 NRP=3 (K[11 69])[73]	n=7 NRP=8 (K[11 69])[70 72–75 77]
>1000 n=14 NRP=18	n=11 NRP=15 (B[5 12 78 79]) (M[80 81])[82–89 98]	n=3 NRP=3[83 84 87]	n=10 NRP=12 (B)[5 12 78 79] (M)	n=5 NRP=5[83 87–89 98]	n=6 NRP=9 (B[5 12 78 79])[83 87–89 98]	n=3 NRP=4 (B[12 79])[90]	n=1 NRP=1[86]	n=3 NRP=3[85 86 89]	n=12 NRP=14 (B[5 12]) (M[80 81])[82 83 85–92]
Study design									
Cross-sectional n=52 NRP=68	n=36 NRP=47 (A[37–39 94 95]) (D[40]) (F[43 96]) (G[2 44]) (H[45 99]) (K[11 69]) (I[19–21]) (J[9]) (L[22 47]) (M[80 81])[25 27 29 30 32 48 49 52 53 55–59 70 71 73 74 83–86 89 97 103]	n=13 NRP=19 (A[37 38 60 94]) (D[40]) (I[19–21]) (K[11 69]) (L[47])[27 30 34 72 83 84 97 103]	n=22 NRP=31 (A[37–39 60–62]) (D[40 63]) (F[43 96]) (I[19 21]) (K[11 69]) (L[47]) (M[80])[3 25 27 33 49 53 64 70 73 75 83 86 89 93 97]	n=10 NRP=17 (A[37–39 60–62]) (D[40]) (I[19 21]) (K[11 69]) (L[47])[49 53 73 83 89]	n=21 NRP=30 (A[37–39 60–62]) (D[40]) (F[43 96]) (I[19–21]) (K[11 69]) (L[47])[3 25 27 33 34 48 49 53 64 70 73 75 83 89 97]	n=23 NRP=27 (A[62 94 95]) (D[63]) (F[43 96]) (G[2]) (H[45]) (I[21]) (L)	n=12 NRP=12 (F[43]) (I[20])[30 32 35 47 48 53 56 59 73 86]	n=21 NRP=26 (A[38 39 62]) (D[40]) (G[44]) (H[99]) (I[19 20]) (K[11 69]) (L[22 47])[30 36 48 49 53 55 56 58 59 73 85 86 89 97 103]	n=36 NRP=45 (A[38 39 62]) (D[40 63]) (F[43 96]) (G[2]) (H[45 99]) (I[19–21]) (K[11 69]) (L[47]) (M[80 81])[3 27 32–36 48 49 53 56 58 65 68 70 73–75 77 83 85 86 89–91 97 103]
Repeated cross-sectional n=3 NRP=5	n=2 NRP=4 (B[5 78 79])[87]	n=1 NRP=1[87]	n=2 NRP=4 (B[5 78 79])[87]	n=1 NRP=1[87]	n=2 NRP=4 (B[5 78 79])[87]	n=1 NRP=1 (B[79])	n=0 NRP=0	n=0 NRP=0	n=3 NRP=3 (B[5])[87 92]
Case–control n=5 NRP=5	n=4 NRP=4 (J[46])[23 24 54]	n=0 NRP=0	n=3 NRP=3 (J[46])[23 54]	n=1 NRP=1[54]	n=1 NRP=1[54]	n=2 NRP=2[24 110]	n=0 NRP=0	n=0 NRP=0	n=3 NRP=3 (J[46])[23 54]
Retrospective cohort n=4 NRP=4	n=3 NRP=3 (B[12])[82 98]	n=0 NRP=0	n=3 NRP=3 (B[12])[82 98]	n=1 NRP=1[98]	n=2 NRP=2 (B[12])[98]	n=1 NRP=1 (B[12])	n=0 NRP=0	n=0 NRP=0	n=2 NRP=2 (B[12])[82]
Prospective cohort n=6 NRP=6	n=4 NRP=4[50 51 72 100]	n=0 NRP=0	n=1 NRP=1[72]	n=0 NRP=0	n=1 NRP=1[72]	n=2 NRP=2[13 112]	n=1 NRP=1[50]	n=0 NRP=0	n=1 NRP=1[72]
Intervention n=5 NRP=7	n=5 NRP=7 (C[17 18]) (E[41 42])[26 28 31]	n=4 NRP=6 (C[17 18]) (E[41 42])[26 28]	n=4 NRP=6 (C[17 18]) (E[41 42])[26 28]	n=3 NRP=4 (E[41 42])[26 28]	n=3 NRP=4 (E[41 42])[26 28]	n=1 NRP=1[26]	n=4 NRP=5 (C[17 18]) (E[42])[26 28]	n=4 NRP=4 (C[17]) (E[42])[26 28]	n=2 NRP=3 (C[18]) (E[41 42])
Data collection methods									
Self-Report Questionnaire n=58 NRP=73	n=16 NRP=20 (F[43 96]) (G[2 44]) (H[45 99]) (M[80 81])[24 32 48 50 51 56 57 59 74 82 86]	n=0 NRP=0	n=9 NRP=11 (A[61 62]) (F[43 96]) (M[80])[3 64 75 82 88 89]	n=4 NRP=4 (A[62])[53 89 98]	n=11 NRP=12 (A[62]) (F[43 96])[3 25 34 48 64 75 88 89 98]	n=23 NRP=27 (A[62 94 95]) (D[63]) (F[43 96]) (G[2]) (H[45]) (L[22 47])	n=16 NRP=17 (C[17 18]) (E[42]) (F[43]) (L[47])[26 28 30 32 35 48 50 53 56 59 73 86]	n=23 NRP=26 (A[38 62]) (D[40]) (E[42]) (G[44]) (H[99]) (I[19 20]) (K[11 69])[26 28 30 36 48 49 53 55 56 58 59 73 85 86 89 97 103]	n=40 NRP=49 (A[38 62]) (C[18]) (D[40 63]) (E[41 42]) (F[43 96]) (G[2]) (H[45 99]) (I[19–21]) (K[11 69]) (J[46]) (L[47]) (M[80 81])[3 32 34–36 48 49 53 54 56 58 65 68 72–75 77 82 83 85 86 88–91 97 103]
Interview n=8 NRP=8	n=1 NRP=1[70]	n=0 NRP=0	n=2 NRP=2[33 70]	n=0 NRP=0	n=2 NRP=2[33 70]	n=4 NRP=4[13 27 33 110]	n=0 NRP=0	n=1 NRP=1 (A[39])	n=6 NRP=6 (A[39])[23 27 33 70 87]
Objectively measured n=37 NRP=50	n=30 NRP=40 (A[37–39 94 95]) (C[17 18]) D[40] E[41 42] (I[19–21]) (K[11 69]) (L[22 47])[25–28 30 49 53–55 58 72 73 83 84 87–89 97 98 100 103]	n=16 NRP=24 (A[37 38 60 94]) (C[17 18]) (D[40]) (E[41 42]) (I[19–21]) (K[11 69]) (L[47])[26–28 30 73 83 84 87 97]	n=24 NRP=32 (A[37–39 60]) (C[17 18]) (D[40 63]) (I[19 21]) (K[11 69]) (J[46]) (L[47])[23 25–28 34 49 53 54 73 83 86 87 93 97 98 103]	n=14 NRP=21 (A[37–39 60 61]) (D[40]) (E[41 42]) (I[19 21]) (K[11 69])[26 28 47 49 54 73 83 87 88]	n=18 NRP=26 (A[37–39 60 61]) (D[40]) (E[41 42]) (I[19–21]) (K[11 69]) (L[47])[26–28 49 53 54 72 73 83 87 88 97]	n=1 NRP=1 (I[21])	n=1 NRP=1 (I[20])	n=2 NRP=3 (C[17]) (L[22 47])	n=1 NRP=1[92]
Secondary data n=1 NRP=4	n=1 NRP=4 (B[5 12 78 79])	n=0 NRP=0	n=1 NRP=4 (B)[5 12 78 79]	n=0 NRP=0	n=1 NRP=4 (B[5 12 78 79])	n=1 NRP=2 (B[12 79])	n=0 NRP=0	n=0 NRP=0	n=1 NRP=2 (B[5 12])
Not reported n=5 NRP=6	n=4 NRP=5 (J[9 46])[23 29 71]	n=0 NRP=0	n=1 NRP=1[72]	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0
Country									
Australia n=8 NRP=9	n=6 NRP=7 (C[17 18])[24 50 51 59]	n=1 NRP=2 (C[17 18])	n=2 NRP=3 (C[17 18])[70]	n=0 NRP=0	n=1 NRP=1[70]	n=3 NRP=3[24 35 90]	n=4 NRP=5 (C[17 18])[35 50 59]	n=2 NRP=2 (C[17])[59]	n=3 NRP=3 (C[18])[35 70]

Continued

Table 1 Continued

	Markers of health						Health behaviours		
	BMI	Circumferences (Waist/hip)	Blood Pressure (measured and reported hypertension)	Blood profile (cholesterol)	Blood profile (glucose, diabetes)	Mental health (stress, fatigue, depression, anxiety)	Diet	Physical activity	Addictive behaviours (alcohol, smoking, illicit drugs)
No of studies (N)	n=53 NRP=71	n=16 NRP=23	n=37 NRP=51	n=17 NRP=25	n=30 NRP=43	n=29 NRP=34	n=17 NRP=18	n=25 NRP=30	n=47 NRP=58
Brazil n=11 NRP=15	n=9 NRP=12 (D[40]) (H[45 99]) (I[19–21],[32 53 74 87 88 97])	n=4 NRP=6 (D[40]) (I[19–21],[87 97])	n=7 NRP=9 (D[40 63]) (I[19 21])[3 53 87 88 97]	n=5 NRP=6 (D)[40] (I[19 21],[53 87 88])	n=7 NRP=9 (D[40]) (I[19–21])[3 53 87 88 97]	n=4 NRP=4 (D[63]) (H[45]) (I[21])[3]	n=3 NRP=3 (I[20],[32 53])	n=5 NRP=6 (D[40]) (H[99]) (I[19 20],[53 97])	n=11 NRP=15 (D[40 63]) (H[45 99]) (I[19-21],[3 32 53 74 87 88 92 97])
Bulgaria n=1 NRP=1	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1 33	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0
Canada n=1 NRP=1	n=1 NRP=1[48]	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0[48]	n=1 NRP=1	n=0 NRP=0[48]	n=1 NRP=1[48]	n=1 NRP=1[48]	n=1 NRP=1
China n=2 NRP=2	n=1 NRP=1[23]	n=0 NRP=0	n=1 NRP=1[23]	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[66]	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[23]
Ethiopia n=1 NRP=1	n=1 NRP=1[58]	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[58]	n=0 NRP=0	n=1 NRP=1[58]	n=1 NRP=1[58]
Germany n=1 NRP=1	n=1 NRP=1[52]	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0
Hong Kong n=2 NRP=2	n=1 NRP=1[56]	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[65]	n=1 NRP=1[56]	n=1 NRP=1[56]	n=2 NRP=2[56 65]
India n=3 NRP=3	n=2 NRP=2[27 103]	n=1 NRP=1[27]	n=3 NRP=3[27 34 110]	n=0 NRP=0	n=2 NRP=2[27 34]	n=1 NRP=1[27]	n=0 NRP=0	n=1 NRP=1[103]	n=3 NRP=3[27 34 103]
Iran n=3 NRP=3	n=1 NRP=1[83]	n=1 NRP=1[83]	n=1 NRP=1[83]	n=1 NRP=1[83]	n=1 NRP=1[83]	n=2 NRP=2[13 110]	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[83]
Italy n=3 NRP=4	n=3 NRP=4 (F[43 96],[71 72])	n=0 NRP=0	n=2 NRP=3 (F[43 96])[72]	n=0 NRP=0	n=2 NRP=3 (F[43 96])[72]	n=2 NRP=3 (F[43 96],[71])	n=1 NRP=1 (F[43])	n=0 NRP=0	n=2 NRP=3 (F[43 96])[72]
Japan n=4 NRP=5	n=4 NRP=5 (M[80 81],[54 82 85])	n=0 NRP=0	n=3 NRP=3 (M[80],[54 82])	n=1 NRP=1[54]	n=1 NRP=1[54]	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[85]	n=4 NRP=5 (M[80 81],[54 82 85])
Kenya n=1 NRP=1	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[68]	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[68]
Mexico n=1 NRP=1	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=1 NRP=1[77]
Netherlands n=2 NRP=2	n=1 NRP=1[29]	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0	n=2 NRP=2[29 112]	n=0 NRP=0	n=0 NRP=0	n=0 NRP=0
South Africa n=1 NRP=1	n=1 NRP=1[73]	n=1 NRP=1[73]	n=1 NRP=1[73]	n=1 NRP=1[73]	n=1 NRP=1[73]	n=1 NRP=1[73]	n=1 NRP=1[73]	n=1 NRP=1[73]	n=1 NRP=1[73]
UK n=1 NRP=2	n=1 NRP=2 (L[22 47])	n=1 NRP=1 (L[47])	n=1 NRP=1 (L[47])	n=1 NRP=1 (L[47])	n=1 NRP=1 (L[47])	n=1 NRP=2 (L[22 47])	n=1 NRP=1 (L[47])	n=1 NRP=2 (L[22 47])	n=1 NRP=1 (L[47])
USA n=27 NRP=41	n=19 NRP=30 (A[37–39 94 95]) (B[5 12 78 79]) (E[41 42]) (G[2 44]) (J[9 46]) (K[11 69],[25 26 28 30 31 49 55 57 84 86 89 98 100])	n=7 NRP=12 (A[37 38 60 94]) (E[41 42]) (K[11 69],[28 30 84])	n=15 NRP=25 (A[37–39 60–62]) (B[5 12 78 79]) (E[41 42]) (K[11 69]) (J[46],[25 26 28 33 49 64 75 86 89 98])	n=8 NRP=15 (A)[37–39 60–62] (E[41 42]) (K[11 69],[26 28 49 89 98])	n=13 NRP=23 (A[37–39 60–62]) (B[37–39 60–62]) (E[41 42]) (K[11 69],[25 26 28 33 49 64 75 89 98])	n=9 NRP=12 (A[62 94 95]) (B[12 79]) (G[2],[26 33 64 67 75 76])	n=5 NRP=5 (E[42],[26 28 30 86])	n=12 NRP=15 (A[38 39 62]) (E[42]) (G[44]) (K[11 69],[26 28 30 36 49 55 86 89])	n=13 NRP=18 (A[38 39 62]) (B[5 12]) (E[41 42]) (K[11 69]) (G[2]) (J[46],[33 36 49 75 86 89 91])
Methodological Quality Assessment									
Poor n=29 NRP=32	n=19 NRP=22 (G[2 44]) (J[9 46]) (K[11 69],[23–25 29 31 50–52 57 59 71 72 74 83 88 100])	n=2 NRP=3 (K[11 69],[83])	n=12 NRP=13 (D[63]) (J[46]) (K[11 69],[3 23 25 33 64 72 83 88 93])	n=3 NRP=4 (K[11 69],[83 88])	n=8 NRP=9 (K[11 69],[3 25 33 64 72 83 88])	n=10 NRP=10 (D[63]) (G[2],[3 24 29 33 35 71 76 90])	n=3 NRP=3[35 50 59]	n=4 NRP=5 (G[44]) (K[11 69],[36 59])	n=15 NRP=16 (D[63]) (G[2]) (J[46]) (K[11 69],[3 23 33 35 36 64 72 74 83 88 90])
Fair n=33 NRP=40	n=25 NRP=32 (B)[5 12 78 79] (C[17]) (D[40]) (F[43 96]) (H[45 99]) (I[19 21]) (M[80 81],[26 28 32 48 49 53–56 70 73 82 84–86 89 97])	n=8 NRP=9 (C[17]) (D[40]) (I[19 21],[26 28 73 84 97])	n=20 NRP=25 (B)[5 12 78 79] (C[17]) (D[40]) (F[43 96]) (I[19 21]) (M[80],[26 28 34 49 53 54 70 73 75 82 86 89 97 98])	n=10 NRP=11 (D[40]) (I[19 21],[26 28 49 53 54 73 89 98])	n=17 NRP=22 (B[5 12 78 79]) (D[40]) (F)[43 96] (I[19 21],[26 28 34 48 49 53 54 70 73 75 89 97 98])	n=11 NRP=13 (B[12 79]) (F[43 96]) (H[45]) (I[21],[13 65 66 68 73 75 110])	n=10 NRP=10 (C[17]) (F[43],[26 28 32 48 53 56 73 86])	n=15 NRP=15 (C[17]) (D)[40] (H[99]) (I[19],[26 28 32 48 53 56 73 85 86 89])	n=24 NRP=29 (B[5 12]) (D[40]) (H[45 99]) (F[43 96]) (I[19 21]) (M[80 81],[26 32 34 48 49 53 54 56 68 70 73 82 85 86 89 91 97])
Good n=14 NRP=23	n=10 NRP=16 (A[37–39 94 95]) (C[18]) (E[41 42]) (I[20]) (L[22 47])[27 30 58 87 92 103]	n=8 NRP=12 (A[37 38 60 94]) (C[18]) (E[41 42]) (I[20]) (L[22 47])[27 30 87]	n=7 NRP=13 (A[37–39 60–62]) (C[18]) (E[41 42]) (L[47])[27 87 103]	n=4 NRP=10 (A[37–39 60–62]) (E[41 42]) (L[47])[87]	n=6 NRP=12 (A[37–39 60–62]) (E[41 42]) (I[20]) (L[47])[27 87]	n=5 NRP=8 (A[62 94 95]) (L[22 47])[27 58 112]	n=5 NRP=5 (C[18]) (E)[42] (I[20]) (L[47])[30]	n=7 NRP=10 (A[38 39 62]) (E[42]) (I[20]) (L[22 47])[30 58 103]	n=12 NRP=15 (A[38 39 62]) (C[18]) (E)[41 42] (I[20]) (L[47])[27 58 67 77 87 92 103]

Letters A-M represent studies comprising of multiple papers.
BMI, body mass index; NRP, number of representing papers.

Table 2 Criteria list for assessment of methodological quality of papers

Questions	Criteria measured	% Papers meeting criteria (n=95)
Q1: Was the research question or objective in this paper clearly stated?	Informativeness	95
Q2: Was the study population clearly specified and defined?	Informativeness	93
Q3: Was the participation rate of eligible persons at least 50%?	Methodology	32
Q4: Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Methodology	69
Q5: Was a sample size justification, power description or variance and effect estimates provided?	Methodology	17
Q6: Were the markers of health/health behaviours/outcomes clearly defined, valid, reliable and implemented consistently across all study participants?	Methodology	78
Quality of papers (no of Questions meeting criteria)		
Good (≥5 items)		25
Fair (4 items)		42
Poor (≤3 items)		33

(<40 mg/dL),[11 28 37–39 60 61 69] based on the ATP III Classification of HDL cholesterol.[107]

Low-Density Lipoprotein (LDL)

Ten studies measured LDL levels,[19 21 26 28 37 40–42 47 61 69 73 83] most measurements were in mg/dL, mean readings ranged from 103.5 mg/dL[28] to 150.4 mg/dL.[83] According to ATP III, all mean LDL values reported in mg/dL were above optimal. Cavagioni *et al* found 25.2% of truck drivers had an LDL of >130 mg/dL,[40] which is borderline-high based on the ATP III classification of LDL cholesterol.[107] This is supported by Lemke *et al* who found that 52.8% of truck drivers had an LDL level of >115 mg/dL.[61]

Triglycerides

Nine studies reported triglyceride levels,[19 21 26 37 40–42 47 60 61 73 83] mean readings ranged from 158.5 mg/dL[40] to 203.1 mg/dL.[21] All reported mean triglyceride levels were >150 mg/dL, which based on the ATP III classification of triglycerides is borderline-high.[107]

Glycaemic control

Seventeen studies measured fasting blood glucose levels,[11 19 21 26–28 37–42 47 49 53 54 60 69 73 83 87 88 97] most were reported in mg/dL, mean readings ranged from 86.3 mg/dL[37] to 125.0 mg/dL.[53] Thirty three per cent of reported mean glucose levels were >110 mg/dL,[11 28 53 69] which based on the ATP III classification of fasting glucose, is a risk factor for the metabolic syndrome.[107] Three studies measured Hemoglobin A1c (HbA1c),[11 49 54 69] with means ranging from 5.0%[69] to 6.1%,[49] two studies of which, reported means within the pre-diabetic range of HbA1c level (>5.7%) according to the American Diabetes Association.[108] While three reported plasma glucose levels[41 47 73] which ranged from 5.2 to 5.7 mmol/L.

Diabetes

Twenty-four studies reported prevalence of type 2 diabetes.[3 5 11 12 25 27 33 34 37 41–43 48 53 61 62 64 69 70 72 73 75 78 79 83 87–89 96–98] Self-reported previously diagnosed type 2 diabetes[3 5 12 25 33 34 43 48 61 62 64 69 70 72 75 78 79 89 96 98] ranged from 1.5%[34] to 17%,[25] while prevalence in those with objectively measured abnormal glucose levels[11 19 27 37 42 53 73 83 87 88] ranged from 3.4%[27] to 18.3%.[37]

Metabolic syndrome

Four studies reported metabolic syndrome prevalence.[37–39 41 60 83 87] Apostolopoulos *et al* found a significantly higher proportion of US truck drivers had metabolic syndrome than a National Health and Nutrition Examination Survey comparative group (73.7% vs 33.8%, respectively),[37] similar findings have been reported elsewhere.[41] Ebrahimi *et al* also found a high prevalence of the metabolic syndrome in Iranian truck drivers of 26.1% based on the ATP definition[107] and 32.6% based on the International Diabetes Federation definition of metabolic syndrome.[83 109]

Mental health

Depression

Nineteen studies reported depression and depressive symptoms prevalence.[2 3 13 22 24 33 35 43 47 62–68 73 75 76 90 96 110] There were limited consistent measurements of depression; self-reported questionnaires were the measurement tool used in 17 studies,[2 3 13 22 24 35 47 62–68 73 75 76 90 110] one study conducted qualitative interviews,[33] and one study reported depression medication use as 0.6%.[43 96] Self-reported symptoms of depression ranged from 6%[90] to 26.9%,[2] 40.8% of a sample of Kenyan truck drivers reported feeling depressed.[68] In a large sample of US occupational groups, Fan *et al* found truck drivers had a twofold higher prevalence of depression than the average US worker.[76] Alavi *et al* found that depression could

increase the likelihood of a road traffic collision in truck drivers (OR 2.4).[13]

Anxiety

Eight studies reported anxiety prevalence.[2 13 22 24 33 43 47 62 67 90 96] Those that compared truck drivers anxiety levels to national averages, found truck drivers had significantly higher values of anxiety.[2 24 47 67] Anxiety was associated with a fourfold increase in likelihood of crashes.[13] Though it appeared self-reported medication use for anxiety was low compared with that of the general population.[43 96 111]

Stress

Ten studies reported on psychological stress.[7 21 27 62 67 76 90 94 95 99 110 112] Ulhoa *et al* found cortisol levels 30 minutes after wakening were higher in irregular shift workers compared with day-shift workers.[21] Orris *et al* used a Symptom Checklist 90 R questionnaire and found US truck drivers were in the 91st percentile for psychological distress compared with the US working population.[67] Similar results were also seen in China.[66] In a separate study, Ulhoa *et al* used a Self-Report Questionnaire and found that 6.1% of the sample had minor psychiatric disorders, with the most common reported stressors being traffic congestion, strict vehicle tracking control, and extended working hours. Thirty-three per cent reported high job demand and 54.9% reported low job control, which were associated with minor psychiatric disorders.[45] Croon *et al* conducted a 2-year prospective cohort study which found that job movement to any job outside of the trucking industry resulted in a larger strain reduction compared with job movement within the trucking industry.[112]

Isolation

Four studies reported on isolation.[2 33 45 110] Ulhôa *et al* found 60.8% of truck driver reported low social support in the workplace.[45] Hatami *et al* showed significantly reduced prevalence of depression in truck drivers who have a codriver than solo truck drivers.[110] Shattell *et al* reported 27.9% of truck drivers mentioned being lonely[2] and 27.1% mentioned they did not have good friendships, with 15.3% saying they had no friends.[33]

Health behaviours

Diet

Seventeen studies reported truck drivers' diet[17 18 20 26 28 30 32 35 42 43 47 48 50 53 56 59 73 86]; of which nine studies measured daily fruit and vegetable intake.[17 18 26 30 42 47 50 56 59 73] This ranged from 1.72 servings/day[30] to 5 servings/day.[47] It is suggested that at least five portions (>400 g) of varied fruits and vegetables should be consumed each day to prevent all-cause mortality, cancers and cardiovascular disease.[113] Wong *et al* found that only 1.1% of truck drivers from Hong Kong ate ≥5 portions of fruits/vegetables per day.[56] Reis *et al* reported that 58.3% of Brazilian long haul truck drivers ate an 'unhealthy diet',[53] similar results were also found in Canada (48%),[48] though neither study reported how this was defined. Additionally, Olson *et al* found that 36.6% of calories in the diet came from fat,[26] exceeding the higher threshold of 15–30% based on WHO guidelines.[114] Korelitz *et al* reported 13.6% of truck drivers ate >3 snacks per day, while the majority of participants (51%) ate two meals per day.[86] Wong *et al* reported that 24.9% of truck drivers from Hong Kong ate at restaurants>10 times a week, this was significantly higher than their professional driver counterparts such as taxi and bus drivers.[56] This is pertinent as the average calorie content in meals from restaurants regularly exceeds that of home cooked meals.[115]

Physical activity

Twenty-six studies observed physical activity levels in truck drivers,[11 17 19 20 26 28 30 36 38–40 42 44 47 49 53 55 56 58 59 69 73 85 86 89 97 99 103] however, only two studies objectively measured physical activity using an accelerometer (GENEActiv)[17 18] and inclinometer (activPAL3).[22 47] Though measurements of physical activity were heterogenous, overall the vast majority of truck drivers did not reach WHO physical activity guidelines.[116] Sangaleti *et al* found 72.8% of Brazilian truck drivers were physically inactive,[97] this is supported by Marqueze *et al* who found 66.7% of truck drivers completed <10 min of physical activity a week.[19] Similar results were found in USA and Ethiopia, with 69.4% and 63.8% of truck drivers reporting no regular exercise, respectively.[44 58] The highest self-reported regular exercise was 57.7% of truck drivers within a different US sample[11 69] and 42.9% of truck drivers in Hong Kong,[56] however, Korelitz *et al* found only 8% of US truck drivers reported regular physical activity, while 49.6% reported never doing physical activity.[86] Layne *et al* found minimal differences between male and female truck drivers levels of physical activity.[36]

Sedentary behaviour

Seven studies reported sedentary behaviour.[11 17 22 38–40 47 62 97 99]
The percentage of waking time spent sedentary in truck drivers varied from 39.4%[38 39] to 78.1%.[53] One study objectively measured sitting time in a sample of truck drivers using inclinometers (activPAL3) and observed truck drivers spent 13 hours/day sitting on work-days, and 8 hours/day sitting on non-workdays.[47] Shorter accelerometer-determined sedentary durations of 9.1 hours/workday were found in an Australian sample.[17] A sample of truck drivers in the USA also self-reported sitting for an average of 4.3 hours/day outside of work.[11]

Addictive behaviour

Smoking

Thirty-eight studies reported on smoking status.[3 11 18–21 23 27 34 36 38–42 46–49 53 54 56 63 65 69 70 72 77 80 82 83 86–89 91 96 97 103] Prevalence of current smokers ranged from 10%[73] to 72.9%,[83] however, categorising 'current smokers' varied between studies and was not defined in some. Jain *et al* found long haul truck drivers were more likely to smoke than delivery drivers, dock workers, mechanics or clerks.[91] Mansur *et al*

found that the smoking prevalence in truck drivers has decreased from 2006 to 2011 by 1.4%,[87] though Sieber *et al* showed that compared with the US adult working population, US long haul truck drivers were more than twice as likely to smoke (51% vs 19%).[89] Moreno *et al* found that although overall prevalence of smoking was high, those who were obese were less likely to smoke.[88] 77% of studies that reported smoking status, reported higher smoking prevalence rates than the global average of 20%.[117]

Alcohol consumption

Thirty-five studies measured alcohol consumption.[2 3 5 11 18 20 21 23 27 32–35 40 43 47 53 54 56 58 62 63 65 68–70 72 73 75 80–82 85–90 97 99]

Alcohol consumption was diversely measured. da Silva-Júnior *et al* reported 48.3% of a sample of Brazilian truck drivers admitted to drinking alcohol during working hours, and 88.6% were aware of similar behaviour in colleagues.[3] Rosso *et al* also found 24.2% of a sample of Italian truck drivers reported drinking during working hours or breaks.[43] Kartikeyan *et al* observed that over half of the Indian truck drivers assessed were classified as alcoholics (ie, consuming >75 g alcohol/day),[34] this is supported by Sharma *et al*, where 57.6% of their Indian truck driving sample were classified as alcoholics.[27] Rice *et al* reported that 14.2% of Australian truck drivers admit to drinking excessively.[35] Hilton *et al* found that using the Alcohol Use Disorders Identification Test questionnaire, 26.8% of their sample of Australian truck drivers were considered alcohol dependent.[90] Mansur found that alcohol consumption in Brazilian truck drivers has decreased from 36.6% in 2006 to 23% in 2011, however, illicit drug use has nearly doubled from 4.1% in 2006 to 8.1% in 2011.[87]

Illicit substances

Seventeen studies measured illicit substance use.[2 3 12 33 35 40 45 49 63 68 70 72–75 87 92 97] Overall self-reported drug use was low. Ulhôa *et al* reported that 0% of Brazilian participants asked used psychotropic drugs,[45] which is similar to findings from a US study.[12] However, Shattell *et al* found a relatively high prevalence of reported use of cannabis (3.4%), opioids (2.5%) and sedatives (1.8%) in the past month in a sample of US truck drivers.[2] Riva *et al* found a higher drug use in a sample of Italian truck drivers where 15.6% reported using recreational drugs, and of those, 12% reported they were addicted.[72] 7.8% of a sample of Brazilian truck drivers tested positive for psychoactive substances.[92] Shattell *et al* interviewed 60 specially selected long haul truck drivers based on their involvement in illegal/illicit behaviours, they found 88.1% admitted to drug use, and of those, 81.6% used crack cocaine.[33] Self-reported stimulant use was high in several studies.[3 40 63 97]

DISCUSSION

The aim of this review was to systematically summarise the literature regarding cardiometabolic risk factors, lifestyle health behaviours and mental health status of truck drivers globally. Findings suggest truck drivers are an at-risk occupational group, exhibiting unhealthy lifestyle behaviours, such as high levels of physical inactivity and sedentary behaviour, poor dietary choices, high consumption of alcohol and high smoking prevalence. This is reinforced by the reported markers of health such as high obesity levels, adverse blood profiles and mental ill health.

Another considerable risk factor for developing cardiometabolic health conditions is age, with truck drivers included in this review typically being middle aged. This is representative of that seen in the real-world setting, where truck drivers are classified as an ageing workforce.[118] Nevertheless, one repeated cross-sectional study in the USA found that the average age of truck drivers has dropped between 2005 and 2012,[79] which is an optimistic trajectory for the future of the road transportation and logistics industry.

It is apparent that truck driving is not conducive to health. Predictive factors for obesity were found to be time behind the wheel,[96] travelling more than 40 000 miles per year[96] and working >11 hours/day.[95] Interestingly, truck drivers with obesity were significantly more likely to rate the exercise environment as bad, and therefore, had more perceived barriers to exercise.[99] A repeated cross-sectional study of USA truck drivers found that BMI has increased significantly from 2005 to 2012.[79] Similarly, the presence of dyslipidaemia had significantly increased from 2006 to 2011.[87] The increase in incidence of obesity and cardiometabolic biomarkers is alarming for the future of truck driving, especially considering drivers with obesity have significantly higher crash risks than healthy weight drivers.[10 44] Obesity also has an economic impact to the employer, as truck drivers with overweight and obesity exhibit higher annual healthcare costs than healthy weight truck drivers.[98] This is particularly pertinent for companies that cover employee health insurance costs.

Implications for future research

Future research is required to evaluate the health of truck drivers in lesser studied regions to gain a more global understanding of the health and implications of truck driving worldwide. Health and well-being programmes that focus on health education should be implemented and prioritised within the logistics industry. In truck drivers, improved education levels have been associated with increased physical activity,[99] reduced BMI[43] and improved mental health status.[3] Where they exist, health and well-being programmes within this industry have been recognised as having the potential of providing beneficial impact on employee health, morale and employee–employer relations.[119] This would also directly benefit employers with increased employee retention, reduced healthcare costs, improved safety and job desirability, combatting the global driver shortage.[118]

Despite their potential, limited health promotion programmes currently exist within the logistics industry and most have been minimally effective.[6] Though primary prevention is vital, interventions should aim to reach a multitude of risk factors by applying multiple

components, targeting health literacy and improving workplace opportunities to make healthy lifestyle choices, in order to gain maximum effectiveness. Research should then determine which components are most effective for improving driver health,[26] and which facilitators and barriers may have affected participant adherence.[120] All stakeholders including drivers, employers, unions, clinicians, truck stops, regulatory agencies and policy-makers should be engaged to achieve these ambitions.

Strengths and limitations

A key strength is the comprehensive review itself, encompassing a large range of cardiometabolic risk factors, health-related behaviours and mental health, thus providing a complete scope of the health status of truck drivers. Strengths also include the thorough search strategy; however, it is possible that some relevant papers were missed due to the English-only search criteria. A further strength is the stringent independent scoring of each paper's methodological quality. One reviewer screened all titles, abstracts, and full texts for inclusion followed by a methodological quality assessment of each included paper. Subsequently, 20% were randomly selected for independent verification at each stage by a second reviewer, which is identified as a limitation of this paper based on the PRISMA guidelines.

Similarly, 33% of included papers were scored 'poor' in the quality assessment, and 24% included small sample sizes (n=<100) which may impact the confidence within the results.

Due to the heterogeneity of measuring and reporting findings from each study, a descriptive synthesis of results appeared most appropriate, though this may have led to inconsistent statistical findings between papers. As a recommendation for future research, authors are encouraged to report and use consistent thresholds for defining the prevalence of certain risk factors to enable a meta-analysis. By presenting all study characteristics and results in online supplemental file 4, transparency has been added. A limitation is the unequal geographical distribution of papers (table 1), ethnicity was predominantly White in all but two studies,[33 66] suggesting the review may not provide a complete representation of the global cardiometabolic and mental health status of truck drivers.

Truck driving is a very heterogeneous job, there are many varieties of truck drivers, predominantly long haul or short haul. Typically, short haul truck drivers are more physically active as they are often loading and unloading their trucks, the distances they travel are smaller and hence their sedentary time is often broken up. They also tend to return home after most shifts and drive less miles overall, which results in an overall healthier way of life. Only 36 included studies reported on the type of truck driver, which warrants consideration.

Another important factor is the law in many countries requires truck drivers to be of adequate health in order to legally operate commercial vehicles on public roads, and as a result, truck drivers are required to undergo regular medical examinations. Truck drivers may be disqualified for a multitude of health conditions and subsequently leave the industry. Consequently, a substantial healthy worker effect is created, as those who are unfit to work will not be included in studies.[121] This may lead to the prevalence of diseases being low, while the prevalence of risk factors for chronic disease are substantial.[48] This reflects the findings from this systematic review, where for example, only 41% of papers reported a mean higher prevalence of type 2 diabetes than the global average (9.3% in 2019).[122]

Notably, addictive behaviour such as alcohol and illicit drug consumptions are likely to be underreported due to fears that it may lead to disciplinary action.[123] Participation bias may also impact these findings, for example, drivers at risk of certain health conditions may choose to not enrol in such studies. This is exacerbated by the certain levels of mistrust frequently seen among truck drivers, often resulting in their reluctance to release personal information, making them a hard-to-reach population.[124]

Similar reviews examining the health of truck drivers have found comparable findings. Abu Dabrh *et al* found that the average BMI of 32 combined studies of truck drivers was 30.5 kg/m^2 and the prevalence of hypertension was 23% (n=1000).[125] A systematic review which examined the health of truck drivers in North America also found the average BMI for all nine included studies was >30 kg/m^2.[126] This is further supported by Prince *et al* who compared cardiometabolic health variability between occupational groups, and found driving-based workers had a higher BMI and blood pressure than other occupational groups.[127] Similarly, a literature review of truck drivers found hypertension in seven studies ranged from 24% to 47.9%, the majority were above the global average.[105 128]

CONCLUSION

Based on the results of this review, there is strong evidence to indicate that truck drivers have a detrimental cardiometabolic and mental health profile in comparison to general populations. Obesity levels and other cardiometabolic risk factors in truck drivers are alarming considering it impacts the safety of all road users. Improving truck driver health is vital for the longevity of the trucking industry. It is imperative to understand that the systemic working conditions that truck drivers endure create a fundamental barrier to the adoption of a healthy lifestyle. These unique job demands include the long irregular hours of enforced sedentarism, which suppress the opportunity for physical activity, alongside the lack of healthy food choices at truck stops, which creates an obesogenic working environment. The workplace plays a vital role in truck driver health; policies, regulations and procedures are required to change in order to address this health crisis.

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Contributors All authors contributed to the conception of the review. AG completed the literature search and quality assessments, Y-LC quality checked 20% of papers at titles, abstract, and full text for inclusion and methodological quality assessment. Any discrepancies were resolved by NP. NP, SC, NJP and JAK revised for critically important content. All authors approved the final version of the manuscript.

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REFERENCES

1 Caddick N, Varela-Mato V, Nimmo MA, *et al*. Understanding the health of lorry drivers in context: a critical discourse analysis. *Health* 2017;21:38–56.
2 Shattell M, Apostolopoulos Y, Collins C, *et al*. Trucking organization and mental health disorders of truck drivers. *Issues Ment Health Nurs* 2012;33:436–44.
3 da Silva-Júnior FP, de Pinho RSN, de Mello MT, *et al*. Risk factors for depression in truck drivers. *Soc Psychiatry Psychiatr Epidemiol* 2009;44:125–9.
4 Freight Transport Association. The Freight transport association logistics report, 2018. Available: https://fta.co.uk/CMSPages/GetFile.aspx?guid=f34d2685-a763-4cd1-bda8-221020fcad3b&lang=en-GB
5 Thiese MS, Hanowski RJ, Moffitt G, *et al*. A retrospective analysis of cardiometabolic health in a large cohort of truck drivers compared to the American working population. *Am J Ind Med* 2018;61:103–10.
6 MK N, Yousuf B, Bigelowa PL, *et al*. Effectiveness of health promotion programmes for truck drivers: a systematic review. *Health Educ J* 2015;74:270–86.
7 Apostolopoulos Y, Sönmez S, Shattell MM, *et al*. Worksite-induced morbidities among truck drivers in the United States. *Aaohn J* 2010;58:285–96.
8 Belzer S. Truck driver occupational safety and health: 2003 conference report and selective literature review, 2007. Available: https://www.researchgate.net/publication/318848708_Truck_Driver_Occupational_Safety_and_Health_2003_Conference_Report_and_Selective_Literature_Review [Accessed 20 Nov 2019].
9 Stoohs RA, Guilleminault C, Itoi A, *et al*. Traffic accidents in commercial long-haul truck drivers: the influence of sleep-disordered breathing and obesity. *Sleep* 1994;17:619–23.
10 Anderson JE, Govada M, Steffen TK, *et al*. Obesity is associated with the future risk of heavy truck crashes among newly recruited commercial drivers. *Accid Anal Prev* 2012;49:378–84.
11 Ronna BB, Thiese MS, Ott U, *et al*. The association between cardiovascular disease risk factors and motor vehicle crashes among professional truck drivers. *J Occup Environ Med* 2016;58:828–32.
12 Thiese MS, Hanowski RJ, Kales SN, *et al*. Multiple conditions increase preventable crash risks among truck drivers in a cohort study. *J Occup Environ Med* 2017;59:205–11.
13 Alavi SS, Mohammadi MR, Soori H, *et al*. The cognitive and psychological factors (personality, driving behavior, and mental illnesses) as predictors in traffic violations. *Iran J Psychiatry* 2017;12:78–86.
14 Liberati A, Altman DG, Tetzlaff J, *et al*. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ* 2009;339:b2700.
15 National Institutes of Health. National heart, lung, and blood Institute quality assessment tool for cross-sectional and cohort studies, 2014. Available: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools
16 Mueller M, D'Addario M, Egger M, *et al*. Methods to systematically review and meta-analyse observational studies: a systematic scoping review of recommendations. *BMC Med Res Methodol* 2018;18:44.
17 Gilson ND, Pavey TG, Vandelanotte C, *et al*. Chronic disease risks and use of a smartphone application during a physical activity and dietary intervention in Australian truck drivers. *Aust N Z J Public Health* 2016;40:91–3.
18 Gilson ND, Pavey TG, Wright OR, *et al*. The impact of an m-Health financial incentives program on the physical activity and diet of Australian truck drivers. *BMC Public Health* 2017;17:467.
19 Marqueze EC, Ulhôa MA, Moreno CRdeC. Effects of irregular-shift work and physical activity on cardiovascular risk factors in truck drivers. *Rev Saude Publica* 2013;47:497–505.
20 Marqueze EC, Ulhôa MA, Castro Moreno CR, *et al*. Leisure-time physical activity does not fully explain the higher body mass index in irregular-shift workers. *Int Arch Occup Environ Health* 2014;87:229–39.
21 Ulhôa MAJ, Marqueze EC, Kantermann T, *et al*. When does stress end? evidence of a prolonged stress reaction in shiftworking truck drivers. *Chronobiol Int* 2011;28:810–8.
22 Varela-Mato V, Clemes SA, King J, *et al*. Associations between musculoskeletal conditions risk, sedentary behavior, sleep, and markers of mental health: a cross-sectional observational study in heavy goods vehicle drivers. musculoskeletal conditions risk in HGV drivers. *J Occup Environ Med* 2019;61:437–43.
23 Baccarelli A, Barretta F, Dou C, *et al*. Effects of particulate air pollution on blood pressure in a highly exposed population in Beijing, China: a repeated-measure study. *Environmental Health* 2011;10:108.
24 Chalmers T, Lal S. Prevalence of affective states in Australian truck and train drivers. *J Australas Coll ROAD Saf* 2016;27:13–18.
25 Heaton K, McManus BJ, Mumbower R, *et al*. A pilot study of sleep, work practices, visual processing speed, and 5-year motor vehicle crash risk among truck drivers. *Workplace Health Saf* 2017;65:572–9.
26 Olson R, Anger WK, Elliot DL, *et al*. A new health promotion model for lone workers: results of the Safety & Health Involvement For Truckers (SHIFT) pilot study. *J Occup Environ Med* 2009;51:1233–46.
27 Sharma PK, Ganguly E. Morbidity profile of long distance truck drivers in Hyderabad City, India. *J Dr NTR Univ Health Sci* 2014;3:234–7.
28 Thiese MS, Effiong AC, Ott U, *et al*. A clinical trial on weight loss among truck drivers. *Int J Occup Environ Med* 2015;6:104–12.
29 van der Beek AJ, Meijman TF, Frings-Dresen MH, *et al*. Lorry drivers' work stress evaluated by catecholamines excreted in urine. *Occup Environ Med* 1995;52:464–9.
30 Whitfield Jacobson PJ, Prawitz AD, Lukaszuk JM, *et al*. Long-haul truck drivers want healthful meal options at truck-stop restaurants. *J Am Diet Assoc* 2007;107:2125–9.
31 Wilson JL, Wolf DM, Olszewski KA. Reducing commercial truck driver BMI through motivational interviewing and self-efficacy. *Workplace Health Saf* 2018;66:270–5.
32 Martins AJ, Martini LA, Moreno CRC. Prudent diet is associated with low sleepiness among short-haul truck drivers. *Nutrition* 2019;63-64:61–8.
33 Shattell M, Apostolopoulos Y, Sönmez S, *et al*. Occupational stressors and the mental health of truckers. *Issues Ment Health Nurs* 2010;31:561–8.
34 Kartikeyan S, Gurav RB, Joshi SD, *et al*. Health and socio-demographic profile of transport workers 2004.

35 Rice SM, Aucote HM, Eleftheriadis D, *et al*. Prevalence and co-occurrence of internalizing and Externalizing depression symptoms in a community sample of Australian male truck drivers. *Am J Mens Health* 2018;12:74–7.
36 Layne DM, Rogers B, Randolph SA. Health and gender comparisons in the long-haul trucking industry: a pilot study. *Aaohn J* 2009;57:405–13.
37 Apostolopoulos Y, Lemke MK, Hege A, *et al*. Work and chronic disease: comparison of cardiometabolic risk markers between truck drivers and the general US population. *J Occup Environ Med* 2016;58:1098–105.
38 Wideman L, Oberlin DJ, Sönmez S, *et al*. Obesity indices are predictive of elevated C-reactive protein in long-haul truck drivers. *Am J Ind Med* 2016;59:665–75.
39 Hege A, Lemke MK, Apostolopoulos Y, *et al*. Occupational health disparities among U.S. long-haul truck drivers: the influence of work organization and sleep on cardiovascular and metabolic disease risk. *PLoS One* 2018;13:e0207322.
40 Cavagioni LC, Geraldo Pierin AM, Pierin AMG. Hypertension and obesity among professional drivers who work transporting loads. *ACTA Paul Enferm* 2010;23:455–60.
41 Olson R, Thompson SV, Wipfli B, *et al*. Sleep, dietary, and exercise behavioral clusters among truck drivers with obesity: implications for interventions. *J Occup Environ Med* 2016;58:314–21.
42 Olson R, Wipfli B, Thompson SV, *et al*. Weight control intervention for truck drivers: the shift randomized controlled trial, United States. *Am J Public Health* 2016;106:1698–706.
43 Rosso GL, Montomoli C, Candura SM. Poor weight control, alcoholic beverage consumption and sudden sleep onset at the wheel among Italian truck drivers: a preliminary pilot study. *Int J Occup Med Environ Health* 2016;29:405–16.
44 Apostolopoulos Y, Sönmez S, Shattell MM, *et al*. Health survey of U.S. long-haul truck drivers: work environment, physical health, and healthcare access. *Work* 2013;46:113–23.
45 Ulhôa MA, Marqueze EC, Lemos LC, *et al*. Minor psychiatric disorders and working conditions in truck drivers. *Rev Saude Publica* 2010;44:1130–6.
46 Stoohs RA, Guilleminault C, Dement WC. Sleep apnea and hypertension in commercial truck drivers. *Sleep* 1993;16:S11–13.
47 Varela-Mato V, O'Shea O, King JA, *et al*. Cross-sectional surveillance study to phenotype lorry drivers' sedentary behaviours, physical activity and cardio-metabolic health. *BMJ Open* 2017;7:e013162.
48 Angeles R, McDonough B, Howard M, *et al*. Primary health care needs for a priority population: a survey of professional truck drivers. *Work* 2014;49:175–81.
49 Bachmann LH, Lichtenstein B, St. Lawrence JS, *et al*. Health risks of American long-distance Truckers. *J Occup Environ Med* 2018;60:e349–55.
50 Brown DJ, Hagger MS, Morrissey S, *et al*. Predicting fruit and vegetable consumption in long-haul heavy goods vehicle drivers: application of a multi-theory, dual-phase model and the contribution of past behaviour. *Appetite* 2018;121:326–36.
51 Hamilton K, Vayro C, Schwarzer R. Social cognitive antecedents of fruit and vegetable consumption in truck drivers: a sequential mediation analysis. *J Nutr Educ Behav* 2015;47:379–84.
52 Ohlendorf D, Troebs P, Lenk A, *et al*. Postural sway, working years and BMI in healthy truck drivers: an observational study. *BMJ Open* 2017;7:e013281.
53 dos RLAP, Costa CDD, Rodrigues DS, *et al*. Obesity, hypertension and diabetes among truck drivers in the middle-west, Brazil. *Biosci J* 2017;33:485–93.
54 Suwazono Y, Okubo Y, Kobayashi E, *et al*. Effect of truck driving on health of Japanese middle aged male workers of a transport company - Multiple regression analyses for blood pressure and HbA_{1C} —. *J Occup Health* 2000;42:239–44.
55 Turner LM, Reed DB. Exercise among commercial truck drivers. *Aaohn J* 2011;59:429–36.
56 Wong CKH, Fung CSC, Siu S-C, *et al*. The impact of work nature, lifestyle, and obesity on health-related quality of life in Chinese professional drivers. *J Occup Environ Med* 2012;54:989–94.
57 Yen W-JJ, Ayodele O, McCarthy A. Predictors of intentions to make healthier eating choices among midwestern truck drivers. *J Epidemiol Glob Health* 2019;9:309–14.
58 Yosef T, Belachew A, Tefera Y. Magnitude and contributing factors of low back pain among long distance truck drivers at modjo dry Port, Ethiopia: a cross-sectional study. *J Environ Public Health* 2019;2019:1–7.
59 Sendall MC, McCosker LK, Ahmed R, *et al*. Truckies' nutrition and physical activity: a cross-sectional survey in Queensland, Australia. *Int J Occup Environ Med* 2019;10:145–50.
60 Lemke MK, Apostolopoulos Y, Hege A, *et al*. Work organization, sleep and metabolic syndrome among long-haul truck drivers. *Occup Med* 2017;67:274–81.
61 Lemke MK, Apostolopoulos Y, Hege A, *et al*. Work, sleep, and cholesterol levels of U.S. long-haul truck drivers. *Ind Health* 2017;55:149–61.
62 Hege A, Lemke MK, Apostolopoulos Y, *et al*. The impact of work organization, job stress, and sleep on the health behaviors and outcomes of U.S. long-haul truck drivers. *Health Educ Behav* 2019;46:626–36.
63 Cavagioni LC, Geraldo Pierin AM. Health problems, hypertension and predisposition to stress in truck drivers. *Rev DA Esc Enferm DA USP* 2009;43:1263–7.
64 Reed DB, Cronin JS. Health on the road: issues faced by female truck drivers. *Aaohn J* 2003;51:120–5.
65 Wong WCW, Tam SM, Leung PWS. Cross-border truck drivers in Hong Kong: their psychological health, sexual dysfunctions and sexual risk behaviors. *J Travel Med* 2007;14:20–30.
66 Shen S, Li Y, Zhou M, *et al*. Depression status and associated factors in Chinese occupational truck drivers. *Cell Biochem Biophys* 2013;67:1497–500.
67 Orris P, Hartman DE, Strauss P, *et al*. Stress among package truck drivers. *Am J Ind Med* 1997;31:202–10.
68 Romo ML, George G, Mantell JE, *et al*. Depression and sexual risk behavior among long-distance truck drivers at roadside wellness clinics in Kenya. *PeerJ* 2019;7:e7253.
69 Thiese MS, Ott U, Robbins R, *et al*. Factors associated with truck crashes in a large cross section of commercial motor vehicle drivers. *J Occup Environ Med* 2015;57:1098–106.
70 Sharwood LN, Elkington J, Stevenson M, *et al*. Assessing sleepiness and sleep disorders in Australian long-distance commercial vehicle drivers: self-report versus an "at home" monitoring device. *Sleep* 2012;35:469–75.
71 Guglielmi O, Magnavita N, Garbarino S. Sleep quality, obstructive sleep apnea, and psychological distress in truck drivers: a cross-sectional study. *Soc Psychiatry Psychiatr Epidemiol* 2018;53:531–6.
72 Riva MM, Cantamessa F, Borleri D, *et al*. Occupational health and safety of road haulage company employees. *Med Lav* 2018;109:180–9.
73 Lalla-Edward ST, Fischer AE, Venter WDF, *et al*. Cross-sectional study of the health of southern African truck drivers. *BMJ Open* 2019;9:e032025.
74 Girotto E, Bortoletto MSS, González AD, *et al*. Working conditions and sleepiness while driving among truck drivers. *Traffic Inj Prev* 2019;20:504–9.
75 Solomon AJ, Doucette JT, Garland E, *et al*. Healthcare and the long haul: Long distance truck drivers--a medically underserved population. *Am J Ind Med* 2004;46:463–71.
76 Fan ZJ, Bonauto DK, Foley MP, *et al*. Occupation and the prevalence of current depression and frequent mental distress, WA BRFSS 2006 and 2008. *Am J Ind Med* 2012;55:893–903.
77 Aguilar-Zinser V, Irigoyen ME, Rivera G, *et al*. Cigarette smoking and dental caries among professional truck drivers in Mexico. *Caries Res* 2008;42:255–62.
78 Thiese MS, Moffitt G, Hanowski RJ, *et al*. Repeated cross-sectional assessment of commercial truck driver health. *J Occup Environ Med* 2015;57:1022–7.
79 Thiese MS, Moffitt G, Hanowski RJ, *et al*. Commercial driver medical examinations: prevalence of obesity, comorbidities, and certification outcomes. *J Occup Environ Med* 2015;57:659–65.
80 Cui R, Tanigawa T, Sakurai S, *et al*. Relationships between sleep-disordered breathing and blood pressure and excessive daytime sleepiness among truck drivers. *Hypertens Res* 2006;29:605–10.
81 Filomeno R, Ikeda A, Maruyama K, *et al*. Excessive daytime sleepiness and alcohol consumption among commercial drivers. *Occup Med* 2019;69:406–11.
82 Cui R, Tanigawa T, Nakano H, *et al*. Associations between weight change since 20 years of age and sleep-disordered breathing among male truck drivers. *Int J Obes* 2009;33:1396–401.
83 Ebrahimi MH, Delvarianzadeh M, Saadat S. Prevalence of metabolic syndrome among Iranian occupational drivers. *Diabetes Metab Syndr* 2016;10:S46–51.
84 Guan J, Hsiao H, Bradtmiller B, *et al*. U.S. truck driver anthropometric study and multivariate anthropometric models for cab designs. *Hum Factors* 2012;54:849–71.
85 Kanazawa H, Suzuki M, Onoda T, *et al*. Excess workload and sleep-related symptoms among commercial long-haul truck drivers. *Sleep Biol Rhythms* 2006;4:121–8.
86 Korelitz JJ, Fernandez AA, Uyeda VJ, *et al*. Health habits and risk factors among truck drivers visiting a health booth during a trucker trade show. *Am J Health Promot* 1993;8:117–23.

87 Mansur AdeP, Rocha MA, Leyton V, *et al*. Risk factors for cardiovascular disease, metabolic syndrome and sleepiness in truck drivers. *Arq Bras Cardiol* 2015;105:560–5.
88 Moreno CRC, Louzada FM, Teixeira LR, *et al*. Short sleep is associated with obesity among truck drivers. *Chronobiol Int* 2006;23:1295–303.
89 Sieber WK, Robinson CF, Birdsey J, *et al*. Obesity and other risk factors: the National survey of U.S. long-haul truck driver health and injury. *Am J Ind Med* 2014;57:615–26.
90 Hilton MF, Staddon Z, Sheridan J, *et al*. The impact of mental health symptoms on heavy goods vehicle drivers' performance. *Accid Anal Prev* 2009;41:453–61.
91 Jain NB, Hart JE, Smith TJ, *et al*. Smoking behavior in trucking industry workers. *Am J Ind Med* 2006;49:1013–20.
92 Leyton V, Bombana HS, Magalhães JG, *et al*. Trends in the use of psychoactive substances by truck drivers in São Paulo state, Brazil: a time-series cross sectional roadside survey (2009-2016). *Traffic Inj Prev* 2019;20:122–7.
93 Stoynev AG, Minkova NK. Circadian rhythms of arterial pressure, heart rate and oral temperature in truck drivers. *Occup Med* 1997;47:151–4.
94 Hege A, Lemke MK, Apostolopoulos Y, *et al*. US long-haul truck driver work organization and the association with cardiometabolic disease risk. *Arch Environ Occup Health* 2017;72:303–10.
95 Hege A, Apostolopoulos Y, Perko M, *et al*. The work organization of long-haul truck drivers and the association with body mass index. *J Occup Environ Med* 2016;58:712–7.
96 Rosso GL, Perotto M, Feola M, *et al*. Investigating obesity among professional drivers: the high risk professional driver study. *Am J Ind Med* 2015;58:212–9.
97 Sangaleti CT, Trincaus MR, Baratieri T, *et al*. Prevalence of cardiovascular risk factors among truck drivers in the South of Brazil. *BMC Public Health* 2014;14:1063.
98 Martin BC, Church TS, Bonnell R, *et al*. The impact of overweight and obesity on the direct medical costs of truck drivers. *J Occup Environ Med* 2009;51:180–4.
99 Franzini Codarin MA, Moulatlet EM, Nehme P, *et al*. Association between practice of physical activity, educational level and food intake profile of truck drivers. *SAUDE E Soc* 2010;19:418–28.
100 Wiegand DM, Hanowski RJ, McDonald SE. Commercial drivers' health: a naturalistic study of body mass index, fatigue, and involvement in safety-critical events. *Traffic Inj Prev* 2009;10:573–9.
101 Robinson CF, Burnett CA. Truck drivers and heart disease in the United States, 1979-1990. *Am J Ind Med* 2005;47:113–9.
102 National Institutes for Health and Clinical Excellence. Public health draft guidance assessing body mass index and waist circumference thresholds for intervening to prevent ill health and premature death among adults from black, Asian and other minority ethnic groups in the UK 1 introduction, 2011. Available: https://www.nice.org.uk/guidance/ph46/documents/bmi-and-waist-circumference-black-and-minority-ethnic-groups-draft-guidance2
103 Chankaramangalam MA, Ramamoorthy V, Muthuraja D, *et al*. Factors associated with hypertension among truck drivers: a cross sectional study at a check post on a national highway in South India. *Int J Med Res Heal Sci* 2017;6:126–9.
104 Public Health Draft Guidance. Assessing body mass index and waist circumference thresholds for intervening to prevent ill health and premature death among adults from black, Asian and other minority ethnic groups in the UK 1 introduction
105 Kearney PM, Whelton M, Reynolds K, *et al*. Global burden of hypertension: analysis of worldwide data. *Lancet* 2005;365:217–23.
106 Bachmann LH, Lichtenstein B, St Lawrence JS, *et al*. Health risks of American long-distance Truckers: results from a multisite assessment. *J Occup Environ Med* 2018;60:e349–55.
107 National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third report of the National cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III) final report. *Circulation* 2002;106:3143–421.
108 ADA. American diabetes association, 2020. Available: https://www.diabetes.org/.[Accessed 26 May 2020].
109 International Diabetes Federation T. The IDF consensus worldwide definition of metabolic syndrome, 2006. Available: file:///C:/Users/psag2/Downloads/IDF_Meta_def_final.pdf [Accessed 4 Apr 2019].
110 Hatami A, Vosoughi S, Hosseini AF, *et al*. Effect of co-driver on job content and depression of truck drivers. *Saf Health Work* 2019;10:75-79.
111 Lewer D, O'Reilly C, Mojtabai R, *et al*. Antidepressant use in 27 European countries: associations with sociodemographic, cultural and economic factors. *Br J Psychiatry* 2015;207:221–6.
112 de Croon EM, Sluiter JK, Blonk RWB, *et al*. Stressful work, psychological job strain, and turnover: a 2-year prospective cohort study of truck drivers. *J Appl Psychol* 2004;89:442–54.
113 Aune D, Giovannucci E, Boffetta P, *et al*. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality-a systematic review and dose-response meta-analysis of prospective studies. *Int J Epidemiol* 2017;46:1029–56.
114 Uauy R, Kumanyika S, Seidell J, *et al*. WHO independent expert report on diet and chronic disease, 2003. Available: https://www.who.int/mediacentre/news/releases/2003/pr20/en/ [Accessed 26 May 2020].
115 Cohen DA, Story M. Mitigating the health risks of dining out: the need for standardized portion sizes in restaurants. *Am J Public Health* 2014;104:586–90.
116 World Health Organisation. Global recommendations on physical activity for health, 2011. Available: https://www.who.int/dietphysicalactivity/physical-activity-recommendations-18-64years.pdf
117 WHO. Who global report on trends in prevalence of tobacco smoking, 2015. Available: www.who.int [Accessed 31 Mar 2020].
118 Costello B, Karickhoff A. Truck driver shortage analysis, 2019. Available: www.atabusinesssolutions.com [Accessed 4 Nov 2019].
119 Husting L, Biddle EA. Truck Safety in the Age of Information. In: *Trucking in the age of information*. Routledge, 2005.
120 Quintiliani L, Yang M, Sorensen G. A process evaluation of tobacco-related outcomes from a telephone and print-delivered intervention for motor freight workers. *Addict Behav* 2010;35:1036–9.
121 Bashkireva AS, Artamonova VG, Khavinson VK. [Productive aging or "healthy worker effect"? Retrospective analysis of morbidity in motor transport drivers]. *Adv Gerontol* 2009;22:539–47.
122 International Federation Diabetes. Worldwide Toll of Diabetes. In: *IDF diabetes atlas*. 9 edn. Brussels, Belgium, 2019. https://diabetesatlas.org/en/sections/worldwide-toll-of-diabetes.html
123 Gjerde H, Christophersen AS, Normann PT, *et al*. Analysis of alcohol and drugs in oral fluid from truck drivers in Norway. *Traffic Inj Prev* 2012;13:43–8.
124 Gill PE, Wijk K. Case study of a healthy eating intervention for Swedish lorry drivers. *Health Educ Res* 2004;19:306–15.
125 Abu Dabrh AM, Firwana B, Cowl CT, *et al*. Health assessment of commercial drivers: a meta-narrative systematic review. *BMJ Open* 2014;4:e003434.
126 Crizzle AM, Bigelow P, Adams D, *et al*. Health and wellness of long-haul truck and bus drivers: a systematic literature review and directions for future research. *J Transp Health* 2017;7:90–109.
127 Prince SA, Elliott CG, Scott K, *et al*. Device-measured physical activity, sedentary behaviour and cardiometabolic health and fitness across occupational groups: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act* 2019;16:30.
128 Erin Mabry J, Hosig K, Hanowski R, *et al*. Prevalence of metabolic syndrome in commercial truck drivers: a review. *J Transp Health* 2016;3:413–21.