Key

(red)	Effect – Statistically significant
(yellow)	Uncertain Effect
(green)	No Effect

(*number*) represents the Oceania Radiofrequency Scientific Advisory Association (ORSAA) ODEB database unique paper id reference
[number] correlates with the bibliographic reference in Karipidis review paper. Refer to the bibliography in Karipidis *et al.*[1] for specific reference information.

Table 7 Epidemiological studies investigating occupational exposure to radar at frequencies above 6 GHz

Important Note: Columns from 'Reference' through to 'Limitations' reproduced from Karipidis *et al.*[1] tables. 'Issues with Karipidis Classification' column is our addition.

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Incorrect OR Assignment - The OR value specified by Karipidis *et al*. (henceforth Karipidis) is for high frequency aerial's, not radar, which is the expected focus of their review paper (>6 GHz). We noted the highest OR for infertility was 5.09 (95% CI, 1.59–16.30) for those aged up to 29 years old working within 5m of radar at very high exposure levels. There were a number age groups exposed to radar that showed a statistically significant linear trend for infertility based on exposure dose. **Funding** – The Royal Norwegian Navy (Military).	[143] Baste et al.	Cross-sectional	Norwegian Navy personnel (10,497 men)	Self-reported	Infertility	OR 1.86 (1.46–2.37)	No information on confounding factors including sailing time
Exposure Assessment Clarification – Exposure measurements were taken at various locations on the boat. Subsequently, a job classification matrix was used to assess typical exposures. **Undisclosed Disease Risk** – Preeclampsia was also assessed but not mentioned. Preeclampsia is a pregnancy complication characterized by high blood pressure and signs of damage to organ systems, most often the liver and kidneys. It affects both mother and the baby. The RR was 6.07 (95% CI, 1.77 to 20.8) for the highest acute exposure group. Testing for a linear trend showed a significant increased risk with higher doses for both outcomes: perinatal death P = 0.01 and preeclampsia P = 0.03. **Risk Estimate Issue** - Risk estimates were provided as a relative risk (RR) not an odds ratio (OR). Karipidis specified an OR 2.87 for acute exposures but neglected to further qualify this RR as being related to a medium exposure dose.	[147] Baste et al.	Cohort (retrospective)	Norwegian Navy personnel followed from 1967 to 2008 (28,337 men)	Job-exposure matrix	Perinatal mortality	Acute exposure OR 2.87 (1.25–6.59); Long-term exposure OR 0.97 (0.69–1.37)	No information on confounding factors; Prone to multiple testing

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Limitations Misstatement - Karipidis claimed "*no information on confounding factors*", which is incorrect. Information was provided and included diesel fumes, vibrations and lead. Other potential factors were controlled to some extent by comparing with personnel from other vessel types as discussed by *Baste et al*. **Funding** - Ministry of Defence (Government/Military).							
Study Population Correction - The population sample size specified by Karipidis was for the study overall which considered other exposures types. The actual population size for the radar group was 22 cases and 58 controls. **Exposure Assessment Comment** - The classification of some job titles and radar exposures in this reviewed study are problematic. Pilots, ships engineers and air traffic controllers were assumed to have zero exposures. This is questionable, as pilots and air traffic controllers frequent airports, which operate radar. In the case of ships engineers, we can safely assume they spend a fair amount of time in the bowels of the ship where exposure would be nil or extremely low. However, an engineer would also have deck time in which exposure could occur. Also surprising, is that crane operators at docks are considered exposed but stevedores and ship loaders are not. This classification may be due to the height of the radar and beam spread but is only relevant for the specific ship being serviced. There are other ships that may be present and operating radar that could be exposing stevedores and ship loaders. If these contentious job titles are considered as part of the never exposed group, then it will likely reduce the association towards a NULL effect. The study authors even made this claim "*For example, men who worked at airports frequently reported exposure to radar. Exposure to radar, however, is rather unlikely unless a person works as a serviceman or controller for radar units*." This judgment is not correct. Airports operate various forms of radar equipment with beams that can travel 10's of kilometres, 360 degrees. Pilots are required to perform external visual inspections of their aircraft as a flight pre-check and so are likely to be exposed. Some airport radars use lower frequencies that will penetrate cockpit windows. Actual measurements should have been taken by the study authors at various locations frequented by personnel to confirm no exposure. **Funding** - Federal Ministry for Education and Research (Government).	[129] Baumgardt-Elms et al.	Case-control	General population of five German cities (269 cases and 797 controls)	Self-reported and expert assessment	Testicular cancer	OR 1.0 (0.60–1.75)	Only 57% of identified controls participated

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Study Population Correction - The population sample size specified by Karipidis was for the study overall which considered other exposures types. The actual population size for the radar group was 45 cases and 52 controls. **Funding** - Intramural Research Program of the NIH, National Institute of Environmental Health Sciences (Government).	[148] Beard et al.	Case-control	U.S. military veterans (621 cases and 958 controls)	Self-reported	Amyotrophic lateral sclerosis	OR 1.74 (0.89–3.38)	Likely under-ascertainment of non-exposed cases; Prone to multiple testing
Comment Only - It is important to clarify that "Expert Assessment" can represent two possible scenarios - Firstly, it can imply actual readings were taken by an expert with a field device or it could be an expert who is familiar with different exposures, and the frequencies used by different types of emitting (radar) equipment. For this study, exposures were measured using a field device. **Comment Only -** Breast/skin/bone/ connective tissue as well as genito-urinary organs both had cancers in the radar exposed group but not in the control group. This was not mentioned by Karipidis. **Funding** - Direction Générale pour l'Armement (Government/Military).	[125] Dabouis	Cohort (retrospective)	French Navy personnel followed from 1975 to 2000 (39,850 men)	Expert assessment	All-cause mortality All-cancer mortality	RR 1.0 (0.88–1.14) RR 0.92 (0.69–1.24)	43 % missing causes of death; No information on relevant confounding factors
Exposure Assessment Clarification - Assessment was based on job role, not job title. **Comment Only** - Confounding factors are not easily determined because the aetiology of testicular cancer is still largely unknown. What was made clear is that all six officers used a radar speed detector in a similar manner and all had some form of testicular cancer. **Funding** – Not Declared	[127] Davis and Mostofi	Cohort (retrospective)	Officers from two police departments in Washington, US, followed from 1979 to 1991 (340 men)	Job title	Testicular cancer	O/E 6.9 ($p < 0.001$)	Exposure was only assessed for the 6 cases in the cohort; No information on confounding factors
Exposure Assessment Clarification - Self-reported/ questionnaire that had expert assessment. **Funding** - National Institutes of Health, Training Grant, Children's Cancer Group Operations Center and Pediatric Oncology Group Operations Office (Government and Institution).	[145] De Roos et al.	Case-control	General US and Canadian population (538 cases and 504 controls, children)	Expert assessment	Neuroblastoma in offspring	OR 2.2 (0.6–8.3)	Result based on only 9 cases and 3 controls exposed to radar
Study Population Clarification - 27,671 was the number of cases. The number of controls was 16,128. **Comment Only** - This is not a high quality study. Such a wide range of possible causes of death were not investigated. Looking at overall mortality potentially masks any associations between exposures and causes of death that may be related to specific types of cancers or neurological conditions as was shown in a subsequent study [124] by the same authors. **Funding** – Not declared.	[123] Degrave et al.	Cohort (retrospective)	Belgian military personnel followed from 1968 to 2003 (27,671 men)	Job title	All-cause mortality	SMR 1.05 (0.95–1.16)	Not all causes of death ascertained (76% in the radar group and 72% in the control group); No information on relevant confounding factors

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Comment Only - Karipidis have been inconsistent when specifying population numbers. In the previous study, Degrave *et al*. [123] Karipidis only accounted for the number of cases. In this study review, both cases and controls were considered by Karipidis in the tally. Undisclosed Disease Risk - Karipidis have been highly selective of the data presented. There was no mention of hemolymphatic cancers which were associated with exposure. The difference in cancer-related deaths was mainly due to hemolymphatic cancers (11 vs. 1 death; Rate Ratio = 7.22), eye and brain tumours (8 vs. 2 deaths; Rate Ratio = 2.71) and other unspecified cancers (11 vs. 3 deaths; Rate Ratio = 2.43). There was also a strong association between exposure and mortality related to "Symptoms, signs, ill-defined conditions". RR 3.51 (95% CI, 1.19–10.33). Funding – Not declared.	[124] Degrave et al.	Cohort (retrospective)	Belgian professional military personnel followed from 1968–2004 (7,349 men)	Job title	All-cause mortality All-cancer mortality	RR 1.04 (0.96–1.14) RR 1.23 (1.03–1.47)	Not all causes of death ascertained (71% in the radar group and 70% in the control group); No information on relevant confounding factors
Observation - Interestingly, radio operators had a significant association with Non-Hodgkin's Lymphoma (NHL) ORa 3.3 (95% CI, 1.5 - 7.1). This was not a focus of Karipidis because it is a lower frequency in the radiofrequency spectrum (i.e., <6 GHz), but may be still relevant for lower frequencies used for 5G. Welding also had an increased risk too ORa 2.6 (95% CI, 1.4 - 5.1). Welding has high exposure to a range of different electromagnetic fields (UV, IR, ELF and even RF in the cases of plastic welders) Funding – Institut National de la Sante et de la Recherche Medicale, Conseil Regional du Languedoc-Roussillon, the Ligue Departementale contre le Cancer, the Federation Nationale des Centres de Lutte contre le Cancer, and the Fondation pour la Recherche Medicale. (Government and Public not for profit).	[137] Fabbro-Peray et al.	Case-control	General population of Languedoc- Roussillon, France (445 cases and 1025 controls)	Job title	Non-Hodgkin's lymphoma	OR 1.3 (0.5–3.3)	Low participation among the controls (52.2%); Low number of cases (7) and controls (14) exposed to radar
Exposure Assessment Clarification - No exposure assessment was performed and so it is assumed by the researchers that all police officers used a radar in their employment. Undisclosed Disease Risk - Karipidis have been highly selective of the data presented. There was no mention of testicular and prostate cancers. There was a weak, non-significant association and trend with radar use. Prostate SIR 1.16 (95% CI, 0.93–1.43) and Testes SIR 1.3 (95% CI, 0.89–1.84) and 1.45 (95% CI, 0.96–2.1) for the longer serving members	[136] Finkelstein	Cohort (retrospective)	Officers from police departments in Ontario, Canada, followed from 1964 to 1995 (22,197 men)	Job title	All-cancer Melanoma	SIR 0.9 (0.83–0.98) SIR 1.45 (1.10–1.88)	No information on confounding factors; Significant loss to follow up (22%)

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Comment Only - We have classified this as uncertain despite SIR for melanoma being 1.45 (95% CI, 1.10 – 1.88) due to authors' comment "*These anatomical sites might absorb energy from radar units, but at this time the author has no information about individual exposures to radar emissions, and it is not possible to draw etiologic conclusions*." We did note that melanoma locations were identified that would normally be covered by clothing – i.e., penis and scrotum (a single case for each). The trunk also had the most instances but solar (Sun) causation cannot be fully excluded. **Funding** – Not declared.							
Exposure Assessment Clarification - An expert assessment was also performed along with the use of a job-exposure matrix. **Undisclosed Disease Risk** - Karipidis have been very selective of only mentioning the "overall" OR. The association between exposure and brain tumours became stronger based on seniority (this usually translates to longer service and therefore potentially longer total exposure – i.e., a dose response relationship. Officers' brain tumour OR 2.11 (95% Cl 1.48-3.01), Senior Officers' brain tumour OR 3.30 (95% Cl 1.99-5.45) **Funding** – Not declared.	[131] Grayson	Case-control (nested)	US Air Force service personnel (230 cases and 920 controls, men)	Job-exposure matrix	Brain cancer	OR 1.39 (1.01–1.9)	Lack of diagnosis confirmation; No potential confounders were included in the analysis
Study Population Correction - The number of men quoted by Karipidis was the total available but the paper abstract and the main body of the research paper clearly says 40,581 men were investigated. **Undisclosed Disease Risk** - Karipidis have been highly selective of the data presented by showing pooled results (all cancers, all causes) which are not useful for determining whether exposure is associated with specific disease endpoints. There were indications for the highest exposures to show increased risk of leukemia. The overall risk was RR 1.48 (95% CI, 1.01 - 2.17) More specifically, some of the leukaemia subtypes showed a definite trend i.e., nonlymphocytic leukemia RR 1.82 (95% CI, 1.05 - 3.14) and acute nonlymphocytic leukemia RR 1.87 (95% CI, 0.98 - 3.58). This was more obvious in Aviation electronic technicians where RR was even higher and significant i.e., ALL Leukaemia RR 2.6 (95% CI, 1.53 - 4.43) and AML RR 3.85 (95% CI, 1.50 - 9.84) **Limitations Misstatement** - Karipidis claimed no information on possible confounders. This is not correct.	122] Groves et al.	Cohort (retrospective)	US Navy personnel followed from 1950 to 1997 (40,890 men)	Job title	All-cause mortality All-cancer mortality	RR 0.87 (0.83–0.9) RR 0.8 (0.74–0.87)	Under-ascertainment of cases; Limited exposure assessment period; No information on possible confounders

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Each job role was investigated for other potential exposures beyond radiation such as solder fumes, chlorinated solvents, oils etc. **Funding** – Not declared.							
No Comments **Funding** - Swedish Cancer Society (Public not for profit), Orebro County Council Research Committee (Government) and the Swedish Medical Research Association (Professional Association).	[128] Hardell et al.	Case-control	General Swedish population (148 cases and 314 controls, men)	Job title	Testicular cancer	OR 2.0 (0.3–14.2)	Result based on only 2 radar workers and 3 controls
Incorrect Case Numbers - The actual number should be 266 because the authors explicitly excluded 5 cases from the study. **Observation** - Although not in scope for review due to the frequency range (i.e., <6 GHz but relevant for lower frequencies used for 5G), a significant association was found for all testicular cancers OR 3.1 (1.4 - 6.9) and other germinal carcinomas OR 3.2 (1.4-7.4). **Funding** – Not declared.	[126] Hayes et al.	Case-control	Patients from medical institutions in Washington, US (271 cases and 259 controls, men)	Self-reported	Testicular cancer	OR 1.1 (0.7–1.9)	Short exposure period; No response rates reported
No Comments **Funding** – National Cancer Institute (Government).	[133] Holly et al.	Case-control	Patients from the Ocular Oncology Unit at the University of California, US (221 cases of 447 controls, men)	Self-reported	Uveal melanoma	OR 2.1 (1.1–4.0)	Prone to multiple testing
No Comments **Funding** - Veneto Region (Government).	[135] LA Vecchia et al.	Case-control	General population Milan, Italy (263 cases and 287 controls)	Self-reported	Bladder Cancer	No association, risk estimate not reported	Prone to multiple testing; Small number of cases across all the agents investigated
Risk Estimate Issue - Odds ratio (OR) was not used, rather prevalence rate was used (PR). **Undisclosed Disease Risk** - Karipidis did not provide details on the risk of being still born which had a higher PR 4.1 (95% CI, 1.7 to 9.9) **Funding** - Royal Norwegian Navy (Military).	[146] Mageroy et al.	Cross-sectional	Norwegian Navy personnel (3,100 births from 1,438 parents)	Self-reported	Congenital anomalies	OR 4.0 (1.9–8.6)	The response rate was only 58%; Prone to multiple testing
Incorrect Personnel Numbers - The specification of 3,752 personnel is incorrect. The number of respondents to the questionnaire was 2,265 people, a mix of military and civilians. Only military men who had completed their compulsory military service were then selected for this study n = 1,487. The two numbers should not have been added together. **Exposure Assessment Clarification** - Self reported with expert assessment **Undisclosed Disease Risk** - Karipidis has not discussed the other health issues associated with exposure that were recorded as P values (not as OR). The two groups more exposed to radiofrequency fields had increased	[144] Mollerlokken et al.	Cross-sectional	Norwegian Navy personnel (3,752 men)	Expert assessment	Infertility	OR 2.28 (1.27–4.09)	No adjustment made for time spent on a boat

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
food and drug allergies (P<0.01 for radar/sonar and P=0.04 for telecommunication), testicular cancer (P<0.01 for radar/sonar and P<0.01 for telecommunication), cardiac infarction (P<0.01 for radar/sonar) and skin cancer (P=0.03 for radar/sonar). **Funding** - The Research Council of Norway (Government).							
Undisclosed Disease Risk - Karipidis have used pooled data and only looked at all-cause mortality as well as all-cancer mortality without presenting any information on individual cancers or other diseases. The aircraft technician (AT) and fire control (FC) group (combined), which are members of the highest exposure groups, clearly show higher mortality rates (MR). Additionally, this study did not just look at mortality but also diseases amongst those still living (further discussed in the comment below). **Comment Only** - Robinette *et al.* provided separate values for death, malignant neoplasms etc. for fire control and aircraft technicians, however, when providing Mortality Ratio (MR) the two groups have been combined. This appears to have been done on purpose to hide the fact that the number of neoplasms and all mortality is double in the aircraft technicians compared to the other exposure groups. There is also a potential misclassification of electronic technicians (ET). An assumption is made that this group would service radars (which would normally not be expected to be functioning at that time of servicing due to risk of over exposure). However, there are many jobs on a ship that require the expertise of an electronics technician that put them in places on a boat that would have low RF. If they are misclassified as a high exposure group instead of being considered as a low exposure group (as we believe they should) this would mean that a number of the non-significant findings found when comparing the low exposure group with the high exposure group would become significant. Not just in mortality but also diseases. When comparing the FC/AT with ET the following was noted: musculoskeletal system, including disorders of bone, joint and muscle, loss of part of the extremities, osteomyelitis and neoplasms of bone or muscle ($p < 0.001$); organs of special sense, which includes eye cataracts ($p < 0.05$); respiratory system, excluding pulmonary tuberculosis which is included among "systemic conditions" ($p < 0.01$); cardiovascular	[121] Robinette et al.	Cohort study (retrospective)	US Navy enlisted personnel followed from 1950 to 1974 (40,890 men)	Job title	All-cause mortality All-cancer mortality	MR 0.96 MR 1.04	Under-ascertainment of cases; Limited exposure assessment period; No information on possible confounding factors

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
system (p < 0.001); and mental disorders, including psychoses, psychoneurotic disorders and so-called "psychophysiologic disorders" (p < 0.05). Many of these health effects are noted in the scientific literature as possibly being associated with microwave exposures. **Funding** – Bureau of Radiological Health (Government).							
Comment Only - The OR provided by Karipidis was for communication/electronic workers. Infantry men on the other hand had a trend for increased brain tumours - Infantry men may be exposed to RF from radio communications equipment, radar from anti-aircraft batteries etc. OR 2.30 (0.89 - 5.99). Important note: musicians were also included with combat infantryman which may skew the results to a NULL effect therefore leading to a potential underestimation of risk. **Comment Only** - We are in agreement with Karipidis on the identified limitation although they simply a restated what the investigators wrote. "*Histopathologic· data were not available for this investigation; consequently, bias toward the null hypothesis may have influenced our results, to the extent that causation varies by tumor type. Similar biases could have occurred as a consequence of our use of the last job title as a surrogate indicator of exposure.*" Such a limitation typically does not extinguish the papers finding; rather it calls for further research. **Funding** - Ministerio da Ciencia e Te,cnologia do Brazil, Conselho Nacional de Desenvolvimento Cientifico e Tecnol6gico and National Institutes of Health NIHS (Government).	[132] Santana et al.	Case-control	Brazilian Navy personnel (40 cases and 671 controls, men)	Job title	Brain cancer	OR 0.56 (0.17–1.82)	Small number of cases (40); Lack of diagnosis confirmation; Use of last job title only
Exposure Assessment Clarification - An expert assessment was also performed. **Comment Only** - Pooled results used. Although it does not change the outcome for the population-based study, the actual OR for radar exposure was 0.8 (95% CI, 0.0 – 6.5). **Observation** - Interestingly a significant association for Uveal Melanoma was found with other RF sources including mobile phones (not relevant for Radar > 6 GHz frequencies although still applicable for the lower frequencies used by 5G). Radio transmitters OR = 3.0 (95% CI, 1.4 – 6.3) Mobile Phone usage OR = 4.2 (95% CI, 1.2 – 14.5) **Funding** - Federal Ministry for Education and Research (Government).	[134] Stang et al.	Case-control	General population of Essen, Germany (118 cases and 475 controls)	Self-reported	Uveal Melanoma	OR 0.4 (0.0–2.6)	High non-response among the population controls (52%)

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Comment Only - Many studies used in this research are comparing exposed with less exposed. There were no studies looking at exposed vs not exposed. Even the less exposed will have some risk particularly in the case with non-linear responses in experimental studies. This type of comparison can therefore lead to an underestimation of risk. **Comment Only** - This is not a high quality study as it looks at pooling of pooled data. There is no investigation of specific types of cancers that maybe associated with RF exposures such as Leukaemia which shows an RR > 1.0. The failure to perform a subgroup analysis is acknowledged by the study authors "*In addition, due to few included studies, we could not separate cancer categories along with individual cancer categories and conduct subgroup analysis. So, we have to combine all the results from included studies to make this meta-analysis*. " Funding - Qazvin University of Medical Sciences in Islamic Republic of Iran (Institution).	[138] Variani et al. (2014)	Meta-analysis	Populations from Groves et al. (2002), Degrave et al. (2009) and Dabouis	Various	All-cancer mortality	MR 0.81 (0.78–0.83)	Only six studies included in the meta-analysis with significant heterogeneity between studies
No Comment **Funding** – Organon (Pharmaceutical Industry).	[142] Velez de la Calle et al.	Case-control	Military personnel from Brest, France (60 cases and 165 controls, couples)	Self-reported	Infertility	OR 0.8 (0.4–1.6)	No comparison in sperm characteristics between cases and controls
Exposure Assessment Clarification - Self reported and job title **Funding** - European Union, French Ministry of Health Department, French Research Department, French Agency for Environmental Safety and Work, the Total-Fina-Elf Group and the AGRICA Group (Government and Industry).	[130] Walschaerts	Case-control	Patients from 5 cities in France (229 cases and 800 controls, men)	Job title	Testicular cancer	OR 0.84 (0.38–1.87)	Low participation (39%) in control group
Listed below are the studies that Karipidis indicated they reviewed but failed to include in their epidemiological table. All entries provided below are taken directly from the studies reviewed and not from the Karipidis report							
Obfuscation - This information should have been included in the table for transparency and consistency. Genotoxicity is an important finding that is also presented in a number of experimental studies and therefore provides some converging evidence of this biological effect of radiofrequency exposures. **Funding** - Ministry of Science, Education and Sport of the Republic of Croatia (Government).	[149] Garaj-Vrhovac et al.	Cohort study (retrospective)	Occupational exposure to radar - 29 exposed subjects and 29 controls	Expert Measurements	Micronuclei and DNA strand breaks	$P < 0.05$	
Obfuscation - This information should have been included in the table for transparency and consistency. The results suggest reduced semen volume and other impacts to sperm attributes which may have fertility implications. The results are also in-line with the majority of studies contained in the ORSAA ODEB database	[140] Hjollund et al.	(Cross Sectional) Observational	Military Personnel 19 Exposed and 489 Controls	Questionnaire and measurements	Immotile Sperm Sperm Morphology Sperm Density Reduce Semen Volume	No P values provided for most parameters but differences were reported that were not favourable for RF exposure	

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
looking at radiofrequency exposure and fertility impairment indicators. **Funding** – Not declared.							
Obfuscation - This information should have been included in the table for transparency and consistency. The results suggest that exposures within the current permitted ICNIRP limits affect the brain, particularly memory. **Funding -** Center for Research on Radiation Sciences (CRRS), Shiraz University of Medical Sciences (Institution).	[150] Mortazavi et al.	Cohort study (retrospective)	100 Radar Workers and 57 Controls	Questionnaire/ self-reported	Reduced reaction time Impaired short-term memory	$P<0.0001$ for both end points	
Obfuscation - This information should have been included in the table for transparency and consistency. **Observation** – While there were some trends observed, what is both interesting and concerning are the findings of improved sperm morphology, motility and volume in the exposed group compared to control. Such a finding goes against the results typically found in the majority of studies investigating these endpoints and RF exposures. It is possible that because the control pool was made up of soldiers who are likely to have exposures to RF from wireless radio transmitters, an underestimation of the effects is possible. This study is related to [139] with this one being a slightly larger study. This study did not reproduce the same finding as the previous "pilot" study. Significant differences were found between the sperm counts in both studies for the microwave exposed: 13 million sperm/mL vs 28.7. Almost all the sperm parameters were superior in the radar exposed compared to the “unexposed”. Claims of a different radar usage for the radar exposed group was used to explain differences in results with pilot study [139] (see below Weyandt et al.). **Funding** – Not declared.	[141] Schrader et al.	(Cross Sectional) Observational	Military Personnel 33 Exposed (Radar Men), 103 Controls	Questionnaire and Job Role (No exposure assessment)	Sperm morphology Sperm motility Sperm volume	$P>0.05$ for all measurements	

Issues with Karipidis Classification/Interpretation/Data	Reference	Type of study	Study population	Exposure Assessment	Disease	Risk Estimate	Limitations
Obfuscation - This information should have been included in the table for transparency and consistency. Changes observed in the tested neurotransmitter/ hormone levels compared to controls may have implications for health. Melatonin is a powerful antioxidant and so a significant reduction can potentially be linked to an oxidative stress state as well as being a potential indicator of circadian rhythm disruption. Increased Serotonin levels can be linked to altered mental states resulting in headaches, anxiety, irritability as well as autonomic hyperactivity resulting in increased sweating and cardiac dysfunction such as rapid/irregular heartbeat and high blood pressure etc. **Funding** – Not declared.	[151] Singh et al.	Cohort study (retrospective)	Military Personnel 68 Controls Group 1: 40 exposed to 8-12 GHz Radar Group 2: 58 exposed to 12.5-18GHz Radar	Questionnaire and Expert Measurements	Melatonin levels, Serotonin levels	Group 1 saw changes compared to both group 2 and the control group but never reached significance P>0.05. Group 2 saw reduced Melatonin P<0.05, Increased Serotonin P<0.05	
Obfuscation - This information should have been included in the table for transparency and consistency. The results suggest defective sperm and reduced sperm counts which may have fertility implications. The results are also in-line with most studies found in the ORSAA ODEB database looking at RF exposure and fertility indicators. **Funding** – Not declared	[139] Weyandt et al.	(Cross Sectional) Observational	Military Personnel	Questionnaire	Sperm count decline Total sperm count Percent motile sperm Linearity differences	P = 0.0085 P = 0.027 P = 0.059 P = 0.064	

Epidemiological review Table 7 summary

1. In summary, our review of Karipidis *et al*. analysis of epidemiological papers investigating radar exposures and health has uncovered a number of concerning issues and include (ranked by severity – lowest first):
   I. Exposure assessment criteria is described incompletely or incorrectly
   II. Errors made in specifying reviewed study population – inconsistent handling of population groups (case and control numbers), wrong population group (other transmitter types outside the scope of review i.e., < 6 GHz) or incorrect population size
   III. Incorrect measures of association specified i.e., OR used when other rates or ratios were actually used
   IV. Claims of study limitations that did not actually exist
   V. Specifying an OR for a population group that was not in scope for review
   VI. Exclusion of six epidemiological studies from table 7, which were only briefly covered in the main body of the review paper
   VII. Of more serious concern was the lack of disclosure of disease risks identified in a number of studies, demonstrating potential confirmation bias and a lack of transparency
2. A review of the available relevant epidemiological literature suggests there is a possible association between hemolymphatic cancers and MMW exposures. Examples include papers [122] Groves *et al*. and [124] Degrave *et al*. along with relevant papers missed by Karipidis showing a similar outcome, namely Cano *et al*. (*219*) and Peleg *et al*. (*3010*). Savitz *et al*. (*4022*) performed a meta-analysis for hemolymphatic cancer studies and

suggested the same. Richter *et al*. (*416*) and Stein *et al*. (*3397*) also found cases. However, these last two papers are case series studies, which were explicitly excluded by Karipidis without providing any detailed justification. One assumes their exclusion was due to inherent limitations that are associated with case series studies. Despite these limitations, case series studies do constitute evidence and provide sentinel indicators for further research.

3. Results may not always be consistent across all studies. However, there are indications of testicular cancer being a potential risk factor as demonstrated by Davis *et al*. [127], Mollerlokken *et al*. [144] and the case series studies performed by Richter *et al*. (*416*) and follow up by Stein *et al*. (*3397*); along with fertility impairment in Weyandt *et al*. [139], Hjollund [140], Mollerlokken *et al*. [144] and Baste *et al*. [143]; birth defects were identified as a risk factor by Mjoen *et al*. (*388*) and Mageroy *et al*. [146]; along with pregnancy complications, Baste *et al*. [147].
4. Karipidis missed or excluded at least 16 epidemiological papers that were available and relevant, when performing their literature search.
   a) Three papers investigating hemolymphatic cancers (all 3 showed an association with RF (>6 GHz) exposure):
      1. Cano *et al*. http://www.ncbi.nlm.nih.gov/pubmed/11563608 (ORSAA paper id *219*)
      2. Peleg *et al*. https://www.sciencedirect.com/science/article/pii/S0013935118300045 (ORSAA paper id *3010*)
      3. Savitz *et al*. https://pubmed.ncbi.nlm.nih.gov/3546635/ (ORSAA paper id *4022*)
   b) Four investigated genotoxicity endpoints (2 found an association with RF (>6 GHz) exposure):
      1. Lalic *et al*. http://www.lib.okayama-u.ac.jp/www/acta/pdf/55_2_117.pdf (ORSAA paper id *362*)
      2. Magdy *et al*. https://www.researchgate.net/publication/46030221_Mutagenic_Potential_of_Radio_Frequency_Electromagnetic_Fields (ORSAA paper id *379*)
      3. Maes *et al*. http://mutage.oxfordjournals.org/content/21/2/139.long (ORSAA paper id *378*)
      4. Garson *et al*. https://onlinelibrary.wiley.com/doi/abs/10.5694/j.1326-5377.1991.tb142282.x (ORSAA paper id *1014*)
   c) One study found an association with “other birth defects” and risk for pre-term births as a result of RF (>6 GHz) exposure:
      1. Mjoen *et al*. http://link.springer.com/article/10.1007%2Fs10654-006-9030-0 (ORSAA paper id *388*)
   d) Three papers found an association between RF (>6 GHz) exposure and an increase in stress hormones (i.e., catecholamines, adrenalin, noradrenalin):
      1. Vangelova *et al*. http://www.ncbi.nlm.nih.gov/pubmed/12096679 (ORSAA paper id *471*)
      2. Vangelova *et al*. https://www.emf-portal.org/en/article/12395 (ORSAA paper id *472*)
      3. Singh *et al*. http://onlinelibrary.wiley.com/doi/10.1002/bem.21925/abstract (ORSAA paper id *540*)
   e) One study investigated various types of cancers, including brain tumours:
      1. Hardell *et al*. http://www.ncbi.nlm.nih.gov/pubmed/11916351 (ORSAA paper id *305*)

Epidemiological "Case Series" Papers missed or excluded by Karipidis *et al*. (5 in total)

Although case series studies may not infer causality and may be prone to bias, they do play an important role in evidence generation and are an integral part of advancing medical knowledge. [2, 3]

ODEB Paper ID	Title	Main Author	Date Published	Frequency Category	Type of Study
415	Review of Extensive Workups of 34 Patients Overexposed to Radiofrequency Radiation	Reeves	01/03/2000	Communications and Radar equipment	Case Series
995	Psychological symptoms and intermittent hypertension following acute microwave exposure	Forman	01/11/1982	X-Band Radar (8-12 GHz)	Case Series
3010	Radio frequency radiation-related cancer: assessing causation in the occupational/military setting	Peleg	01/05/2018	Powerlines, Radio antennas and Radar (ELF, MHz to 30 GHz)	Case vs Case
416	Cancer in radar technicians exposed to radiofrequency/microwave radiation: sentinel episodes	Richter	01/07/2000	Powerlines (ELF), Radio Antennas (MHz) and Radar (7.5-18 GHz)	Case Series
3397	A sentinel case series of cancer patients with occupational exposures to electromagnetic non-ionizing radiation and other agents	Stein	17/01/2011	Powerlines, Radio antennas and Radar (ELF, MHz to 30 GHz)	Case Series

Epidemiological Papers missed or excluded by Karipidis *et al*. (11 in total)

ODEB Paper ID	Title	Main Author	Date Published	Frequency Category	Type of Study
219	Non-Hodgkin's lymphomas and occupation in Sweden	Cano	01/08/2001	Various occupations exposed to radio broadcast and potential radar (ships pilots)	Prospective Cohort
305	Ionizing radiation, cellular telephones and the risk for brain tumours	Hardell	01/12/2001	Telecommunications and Radar workers (exact frequency range not specified)	Case Control
362	Comparison of chromosome aberrations in peripheral blood lymphocytes from people occupationally exposed to ionizing and radiofrequency radiation	Lalic	01/04/2001	50-60Hz and 30kHz – 30GHz	Cross Sectional
378	Cytogenetic investigation of subjects professionally exposed to radiofrequency radiation	Maes	01/03/2006	450, 900 MHz, RF-dipole antennas (147.25, 164.35 and 169.625 MHz) and parabolic antennas (6 and 40 GHz)	Cross Sectional

ODEB Paper ID	Title	Main Author	Date Published	Frequency Category	Type of Study
379	Mutagenic Potential of Radio Frequency Electromagnetic Fields	Magdy	01/04/2002	Radio Transmitters and Radar (exact frequency range not specified)	Cross Sectional
388	Paternal occupational exposure to radiofrequency electromagnetic fields and risk of adverse pregnancy outcome	Mjoen	21/07/2006	MHz to GHz, Occupational exposures to Radio Transmitters, Radar etc. (exact frequency range not specified)	Cohort Retrospective
471	The effect of low level radiofrequency electromagnetic radiation on the excretion rates of stress hormones in operators during 24-hour shifts	Vangelova	01/06/2002	Satellite and TV broadcast transmitters (3-300MHz, 410 MHz and 9.375 GHz)	Cross Sectional
472	Variations of melatonin and stress hormones under extended shifts and radiofrequency electromagnetic radiation	Vangelova	01/04/2005	Satellite and TV broadcast transmitters (exact frequency range not specified similar to ORSAA OEDB paper id 471)	Time-Series
540	Occupational EMF exposure from radar at X and Ku frequency band and plasma catecholamine levels	Singh	01/09/2015	Radar X (8–12 GHz), and Ku (12.5–18 GHz) bands	Cross Sectional
1014	A chromosomal study of workers with long-term exposure to radio-frequency radiation	Garson	02/09/1992	Telecommunication Workers - 400 kHz - 20 GHz	Cross Sectional
4022	Leukemia and occupational exposure to electromagnetic fields: review of epidemiologic surveys	Savitz	1987	Telegraph, Linesman and Radar Operators (exact frequency range not specified)	Review/Meta Analysis

References

1. Karipidis K, Mate R, Urban D, Tinker R, Wood A. 5G mobile networks and health-a state-of-the-science review of the research into low-level RF fields above 6 GHz. J Expo Sci Environ Epidemiol. 2021; 31:585-605.
2. Jackevicius C. The Value of Case Reports. Can J Hosp Pharm. 2018;71(6):345-346.
3. Murad MH, Sultan S, Haffar S, Bazerbachi F. Methodological quality and synthesis of case series and case reports. BMJ Evid Based Med. 2018 Apr;23(2):60-63.