

Socio-economics status and metabolic syndrome: A meta-analysis

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Title: Socio-economics status and metabolic syndrome: A meta-analysis

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Short title: **Socio-economics status and metabolic syndrome**

Abbreviations:

SEG = socio-economic gradient

METs= Metabolic syndrome

HDI= Human Development Index

WHO= World Health Organization

IDF= International Diabetes Federation

NECP-ATP III= National Cholesterol Education Program-Adult Treatment Panel III

AHA= American Heart Association

BMI= Body Mass Index

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C. Mourgues: redaction of the article, analyses, correspondence between authors, coordination of the work, selection of the reviewed articles, design of the article.

A. Pélissier: redaction of the article, translation in English version and selection of the reviewed article.

A. Legrand: redaction of the article and statistical analyses

M Blanquet: redaction of the article and selection of the reviewed articles.

Ethical standards disclosure:

"This study was conducted according to the guidelines laid down in the declaration of Helsinki". Our work is a meta-analysis so we use published data.

Abstract

Objective

The metabolic syndrome (MetS) is responsible for an increased risk of type 2 diabetes, cardiovascular diseases and is associated with all-cause and cardiovascular mortality. Economic and social vulnerability is not an easy concept to grasp, but some studies investigate the association between MetS and socioeconomic and demographic factors, deprivation (more often correlations rather than causal one due to data). This work aims to assess the association between MetS and socio-economic gradient (SEG) in the literature by performing a meta-analysis.

Design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for systematic reviews were followed.

Setting

The raw list of studies extracted from PubMed as regard to the inclusion/exclusion criteria was imported in Word. Studies were filed with regard to our three definitions of SEG and their title.

Participants

Subgroup analysis were performed considering several definitions of Mets: NCEP-ATPIII and IDF2006.

Results

The overall multivariable-adjusted OR showed that the risk of MetS was significantly increased in association with SEG The results of the subgroup analysis showed an increased risk of MetS in association with SEG when IDF definition was considered.

Conclusions

Targeted interventions must be implemented in a specific way as prevention campaigns aimed at the general population are generally not adapted to this particular vulnerable population.

Introduction

The metabolic syndrome (MetS) is a set of physiological and biochemical disorders that includes elevated fasting glucose, high blood pressure, dyslipidaemia, and abdominal obesity. It is responsible for an increased risk of type 2 diabetes, cardiovascular diseases and is associated with all-cause and cardiovascular mortality .

The prevalence of MetS is not easy to measure, suffering from MetS relies on biological tests and physical examination. The prevalence rate of MetS among adults measured in the literature is heterogeneous – mainly ranging from 12% to 35%. First, the estimates depend on the population studied for examples, Enkh-Oyun et al. (1) estimated the prevalence of MetS at 32.8 % for a representative sample in Mongolia while the prevalence rates for Malaysia is 16.6% (2).Second, prevalence depends on the definition retained for MetS, in the Turkish adult population prevalence vary from 27.4% to 36.9 % considering the definition applied (3). There are several guidelines (Table 1): the World Health Organization (WHO 1998) (4), the National Cholesterol Education Program-Adult Treatment Panel III (NECP-ATP III 2005) (5), the American Heart Association (AHA 2005) (6), the International Diabetes Federation (IDF 2006) (18), that why an harmonized definition from IDF/AHA/National Heart Lung and Blood Institute has been performed considering ethnic group's characteristics (2009) (8). Differences between those definitions relate to the number of criteria (blood pressure, triglycerides, HDLC, Fasting glucose BMI or waist circumference). For example WHO definition selected intolerance IGT in addition with 2 or more criteria, IDF (2006) kept abdominal obesity in addition with two others factors too, whereas the others definitions selected 3 or more criteria.

Economic and social vulnerability is not an easy concept to grasp – and so to measure – given its multidimensionality. More precisely, the socio-economic gradient can be understand in several way and can particularly be associated to the concept of social deprivation. Social deprivation has been defined by J. Wrezinski as "the lack of [one or more of the prerequisites of] security, such as a job, enabling individuals and families to assume occupational, family, and social responsibilities and to enjoy basic rights." (9). At the same time, Townsend defined the concept of deprivation as a "state of observable and demonstrable disadvantage relative to the local community or the wider society to which an individual, family or group belongs." He applied this concept to conditions rather than resources and distinguished between deprivation and poverty (10). He also argued that deprivation is the main cause of inequalities in health and developed an index to measure deprivation over given geographic areas (8).

Studies investigate the association – more often correlations rather than causal one due to data limitations – between prevalence of MetS and socio-economic and demographic factors. These studies help to characterize for a given sample the people with higher risk to develop MetS. Variables such as gender, age, income level, education level or marital status are investigated in this literature in order to highlight the existence or not of a socio-economic gradient in the prevalence of MetS. The assumption is that socioeconomic deprivation is associated with Mets. In a review of literature miscellaneous variables were used to define socioeconomic status from one variable to several one and by adding variables or by integrating them into a score.

The diversity in measurement of MetS, sample studied and causal association investigated make difficult to compare and synthetize the results from the literature. This work aims to assess the association between MetS and socio-economic gradient (SEG) in the literature by performing a meta-analysis.

1. Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for systematic reviews were followed(11,12).

2.1 Search strategy and eligibility criteria

A systematic review was performed on PubMed, published in English until October 17, 2017 and that assess the association between MetS and SEG. Inclusion criteria were:

(1) MetS was measured in adults (18+ years old) according to at least one of the following definitions: NCEP ATPIII 2001 (5), IDF 2006 (7), WHO 1998 (4), Harmonized definition 2009 (8), AHA 2005 (6) [TABLE 1],

(2) SEG was investigated by three definitions – more or less enlarged –: we targeted (keywords of the research) the links between MetS and: i) psychosocial deprivation, ii) economic status, and iii) socio-economic status (SES)

(3) Only observational quantitative studies were considered (cohort and cross sectional studies).

Exclusion criteria were:

(1) the full-text manuscript was not accessible,

(2) the publication was only in symposium or conference abstracts, book chapters, case reports or letters to the editor.

1.2 Study selection

The raw list of studies extracted from PubMed as regard to the inclusion/exclusion criteria was imported in Word. Studies were filed with regard to our three definitions of SEG and their title.

The final list of studies retained for the meta-analysis was set up thanks to a three-step process. First, two independent reviewers (one health economist and one MD with nutrition and health economic skills) screened the title and the abstract of each study listed in the Word file. The disagreements or questions were seen by all the authors together until a consensus

was reach. Second, two of the authors separately reviewed the full-text manuscripts to check precisely the eligibility criteria and to identify by indirect search from the bibliography others studies likely to meet the eligible criteria. Third, the same procedure (steps 1 and 2) was applied for each of the studies found by indirect search. The final list was imported in Excel. Countries were classified to the Human Development Index (HDI) created by the United Nations Development Program, for estimating country human development level (life expectancy, education level and standard of living).

2.3 Data extraction and assessment of study quality

Three of the authors extracted the data. Each study included in the aforementioned final list was analysed independently by at least two of these three authors. The databases that resulted from these analyses were compared and combined into a final one, ready for the meta-analysis. Disagreements were resolved by consensus among all the authors. Data extracted concern [supplementary data]:

(1) study identification (title, name of the two first authors, publication date),

(2) study characteristics (country, city, design of the study, sample size),

(3) sample characteristics,

(4) definition of MetS,

(5) variables measuring SEG (list and definition of the variables),

(6) prevalence of MetS,

(7) limits of the study.

1.4 Statistical analysis

The odds ratio (OR) was considered as the common measure of the association between SEG with MetS. Fixed effects models were used to aggregate a mean log OR and 95% CI as the meta-analysis included only observational studies. The I^2 statistic, which measures the percentage of the total variation across studies due to heterogeneity, was assessed.

Heterogeneity was considered to be present if I^2 was superior to 50%. Publication bias was assessed by Begg rank correlation test.

Subgroup analysis were performed considering several definitions of Mets: NCEP-ATPIII and IDF2006.

All statistical analyses were performed using SAS software (version 9.4, SAS Institute, Cary, NC, 2002-2012).

2. RESULTS

2.1 Study identification and selection

The direct search by initial keyword « metabolic syndrome » led to 66 748 articles, 66 031 were excluded as they were not relevant. Given our inclusion/exclusion criteria and the completion of steps 1 and 2 of our methodology (section 2.2), we retained 41 articles: 3 dealing with « MetS and psychosocial deprivation", 18 with "MetS and economical status" and 8 with "MetS and socio-economic status". From these articles, we extracted 32 additional studies by indirect search (step 3 described in section 2.2). Finally, our database for the meta-analysis count 73 articles, as presented in the flow-chart (Figure 1).

2.2 Study characteristics

In the 73 studies selected, publication year went from 2003 to 2017. Among them, 15 were longitudinal studies (cohorts) (13–27) and 58 were cross sectional studies (1–3,28–80). Regarding Human Development Index (HDI), 35 studies were set in countries classified as very high (13–17,19,20,22,24–26,28–34,36,39–42,44,48,49,51,52,62,64,66,72,77,78,80); 23 in countries classified as high (1–3,21,28,35,37,42,43,45–47,50,57,58,60,65,67,68,71,73,76,81), 14 (18,27,38,53–56,59,63,69,70,74,79,82) in countries classified as mid and 1 (61) in a country classified as low. The sample size ranged from 374 to 217 216 for a total number of 561 758. Several definition of MetS were used: 20 studies used

IDF 2006 definition, 48 used NCEP-ATPIII, 7 used 2009 harmonized definition, 14 used AHA 2005 and 7 used another definition WHO 1998 (or incomplete definition compared with those reported in table 1).

2.3 Socioeconomic gradient and MetS

Results are presented in figures 2, 3, 4 and 5. The overall multivariable-adjusted OR showed that the risk of MetS was significantly increased in association with SEG (OR=1,15, 95%CI=1,12-1,18,), a substantial level of heterogeneity was observed among studies (p<0.0001, I2=98.2). No publication bias was observed according to Begg test (p=0.37) (figure 2).

The results of the subgroup analysis based on definition of MetS showed an increased risk of MetS in association with SEG when IDF definition was considered (OR=1,16, 95%CI=1,02-1,33) with a substantial level of heterogeneity among studies (p=0.03, I^2=84.3). No publication bias was observed according to Begg test (p=0.25) (figure 3).

The same association was found when NCEP-ATPIII was used (OR=1,21, 95%CI=1,17-1,25) with a substantial level of heterogeneity among studies (p<0.0001, I^2=98.8). No publication bias was observed according to Begg test (p=0.25) (figure 4).

However, no association was found when considering the other definitions of MetS and SEG (OR=1.04, 95%CI=1.00-1.09) (figure 5).

3. DISCUSSION

We conducted a meta-analysis over 73 articles on the link between SEG and MetS. Our study showed that economic and social vulnerability, i.e. low SEG measured as regard to psychosocial deprivation, economical status and SES, is a risk associated with Mets.

More precisely, 62 studies of our database underlined this positive association between SEG and MetS. The 11 that did not were mostly cross-sectional studies with low sample size

(<1000 individuals), suggesting that they probably lacked statistical power to put in light a significant correlation between SEG and MetS. Interestingly, our results seemed to be robust. The link we underlined between SEG and MetS was significant and positive whatever the characteristics of the studies (e.g. design, HDI of the country) and the definitions retained for SEG and MetS (IDF or NCEP-ATPIII).

To our knowledge, this meta-analysis is the first one of the link between economic and social vulnerability and MetS. Thus, our study provides a comprehensive list of articles that deal with SES and MetS through our systematic review and synthesizes the existing results through our meta-analysis.

Given the prevalence of MetS is increasing in recent years (83), identifying population-at-risk would participate to a more effective screening and prevention (primary and secondary), particularly when this population-at-risk is also a population concerned by a low access to healthcare services. It has been demonstrated that economic and social vulnerability is a risk factor for various pathologies, particularly for cardiovascular diseases (84) . In our study, SEG appears as an independent factor of MetS. This is an expected result as the prevalence of obesity and of type 2 diabetes is higher in the vulnerable population than in general population. Obesity if one of the components of MetS and MetS is also a risk factor for type 2 diabetes.

Our results must be nuanced. First, during the study selection phase, 81 studies met the inclusion criteria but for six of them the necessary data were not available. Second, regarding the definition of MetS, studies mainly retained the definition of NCEP-ATPIII or that of IDF. We analysed them independently and as we pointed out above, they gave the same results than the global analysis. We examined also the others definitions of MetS, within a unique sub-sample (given the low number of studies concerned by each definition): the link between SES and MetS was not significant. Such a result can be explained by the heterogeneity of the

definitions that can led to bias in the ranking of the studied population with regard to the definitions of the scientific and international societies. Third, there is no unique definition for economic and social vulnerability. It can be economic, social or psychosocial. An analysis per type of vulnerability could show different links with MetS in terms of significance, sign and magnitude. In our study, we were unable to do this sub-sample analysis, as the number of studies for some definitions was too small. Fourth, the measure of consistency in our meta-analysis (I^2) showed there was a great heterogeneity among our pool of studies. Lastly, our meta-analysis focused only on the link between SEG and MetS. Further analysis would be required to take into account other potential confounding factors known to be linked to the risk of Mets including gender, age and education level. The data included in the analysis were aggregated data, only the marginal totals were available so that individual characteristics could not be assessed.

4. CONCLUSION

Economic and social vulnerability is associated with Mets. Further publications are necessary to confirm those results with harmonized definitions of both Mets and economic and social vulnerability. Targeted interventions must be implemented as prevention campaigns aimed at the general population are not adapted to this particular vulnerable population.

5. KEYWORDS

Meta –analysis, metabolic syndrome, economic gradient, lifestyle

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Tables

Table 1: Definitions of the Metabolic Syndrome

	WHO 1998	**NCEP-ATP III 2001**	**AHA 2005**	**IDF 2006**	**Harmonized definition 2009**
Metabolic Syndrome	**Glucose intolerance, IGT or T2D and/or IR + 2 or more criteria**	**3 or more criteria**	**3 or more criteria**	**Abdominal obesity + 2 other factors**	**3 or more criteria**
Waist to hip ratio And/or BMI	M >0.90 ; W >0.85 >30kg/m²				
Waist Circumference (cm)		M >102 W >88	M >102 W >88	Europe: M ≥ 94; W ≥ 80 South Asians/Chinese: M ≥ 90; W ≥ 80 Japanese: M ≥ 85; W ≥ 80	Population- and Country-specific definitions
Blood Pressure (mmHg)	≥ 160-90	≥ 130/85	≥ 130/85 or med for HBP	sBP ≥130 or dBP ≥ 85 or med for HBP	sBP ≥130 and/or dBP ≥ 85 or med for HBP
Triglycerides mmol/l (mg/dL)	≥ 1.7 (150)	≥ 1.7	≥ 1.7	≥ 1.7 or med for HTG	≥ 1.7 or med for HTG
HDL-C	HTG and/or	M< 1.0 ; W< 1.3	M< 1.0 ; W< 1.3	M< 1.0 (40); W< 1.3 (50)	M< 1.0; W< 1.3;

mmol/l (mg/dL)	M< 35 ; W< 39			or med for rHDL-C	or med for rHDL-C
Fasting Glucose mmol/l (mg/dL)	IGR or T2D, IR	≥ 6.1 (110)	≥ 5.6 (100) or diagnosed T2D	≥ 5.6 or diagnosed T2D	≥ 5.6 or T2D
Other	µalb ≥ 20µg/min or acr ≥ 20mg/g				

Figures :

Figure1: meta-analysis flow chart

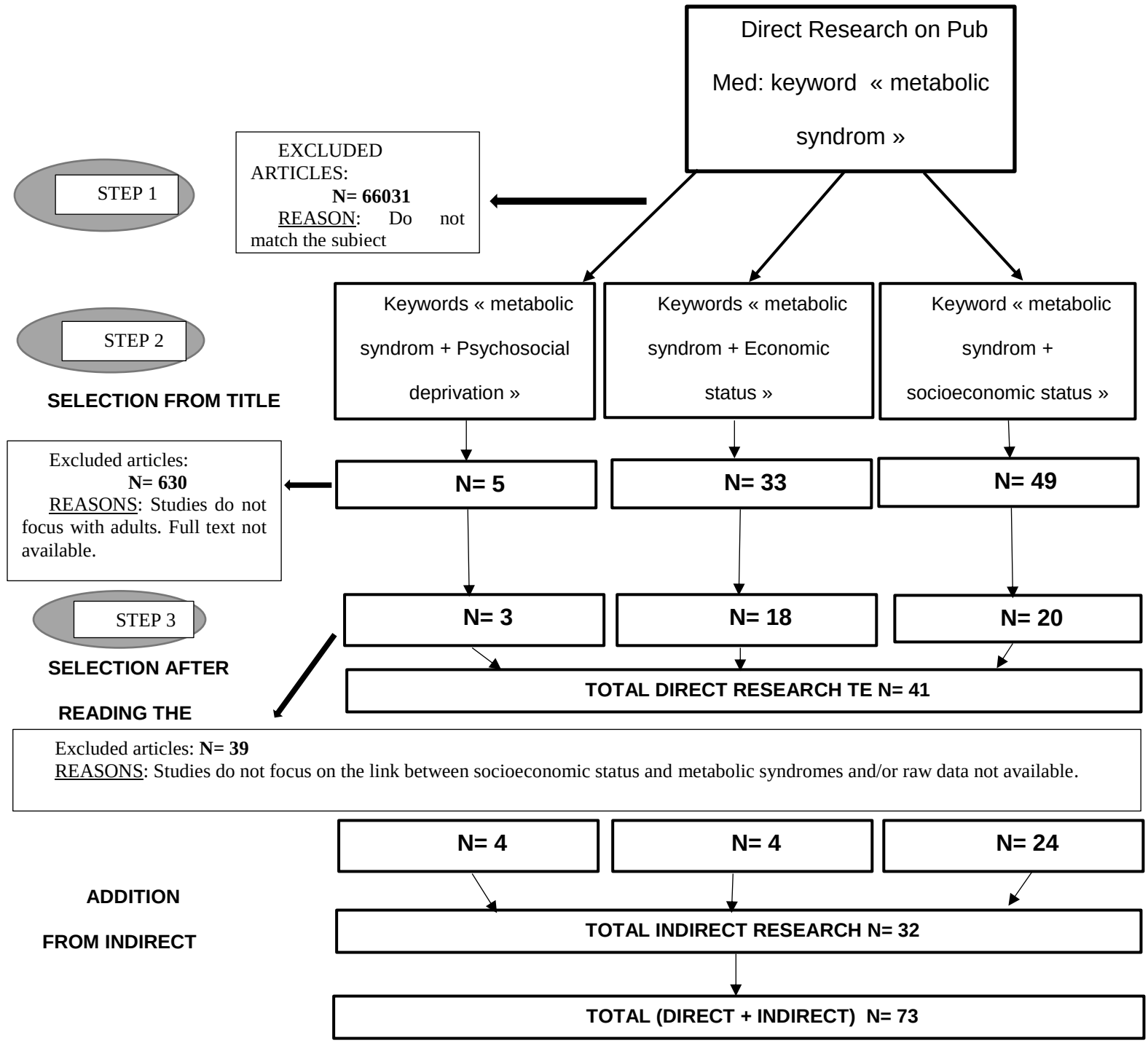


Figure 2 : Overall multivariate-adjusted OR

STUDY	Publication year	OR	CI95%
E4	2010	1.96	1.42-2.72
E6	2016	1.18	0.61-2.27
E9	2011	0.34	0.18-0.63
E11	2005	1.77	1.49-2.09
E12	2014	0.64	0.59-0.69
E15	2013	1.71	1.23-2.36
E16	2014	2.85	2.61-3.11
E18	2010	0.99	0.75-1.32
E19	2010	1.13	0.84-1.52
E20	2013	0.94	0.34-2.56
E22	2007	0.88	0.63-1.22
E23	2005	0.75	0.42-1.36
E25	2011	1.35	0.60-3.02
E26	2015	1.27	1.16-1.39
E27	2016	0.99	0.72-1.36
E34	2008	0.65	0.60-0.71
E42	2008	0.88	0.76-1.01
E43	2007	1.70	1.54-1.87
E44	2014	0.43	0.34-0.55
E45	2012	1.41	1.20-1.65
E47	2015	1.26	1.04-1.54
E48	2014	0.64	0.58-0.70
E53	2016	1.35	0.90-2.02
E55	2008	1.00	0.75-1.34
E57	2012	0.65	0.49-0.85
E65	2008	1.17	0.98-1.40
E69	2004	1.33	1.19-1.49
E70	2012	1.39	1.01-1.90
E73	2016	2.39	2.04-2.79
E74	2016	3.85	3.46-4.28
E75	2006	1.71	1.38-2.11
E76	2011	0.06	0.04-0.09
E79	2010	0.77	0.49-1.20
E80	2010	0.50	0.32-0.78
E81	2013	1.10	0.90-1.35
E85	2012	0.75	0.49-1.14
E93	2009	0.74	0.64-0.85
E95	2010	1.20	0.99-1.45
MH_		1.15	1.12-1.18

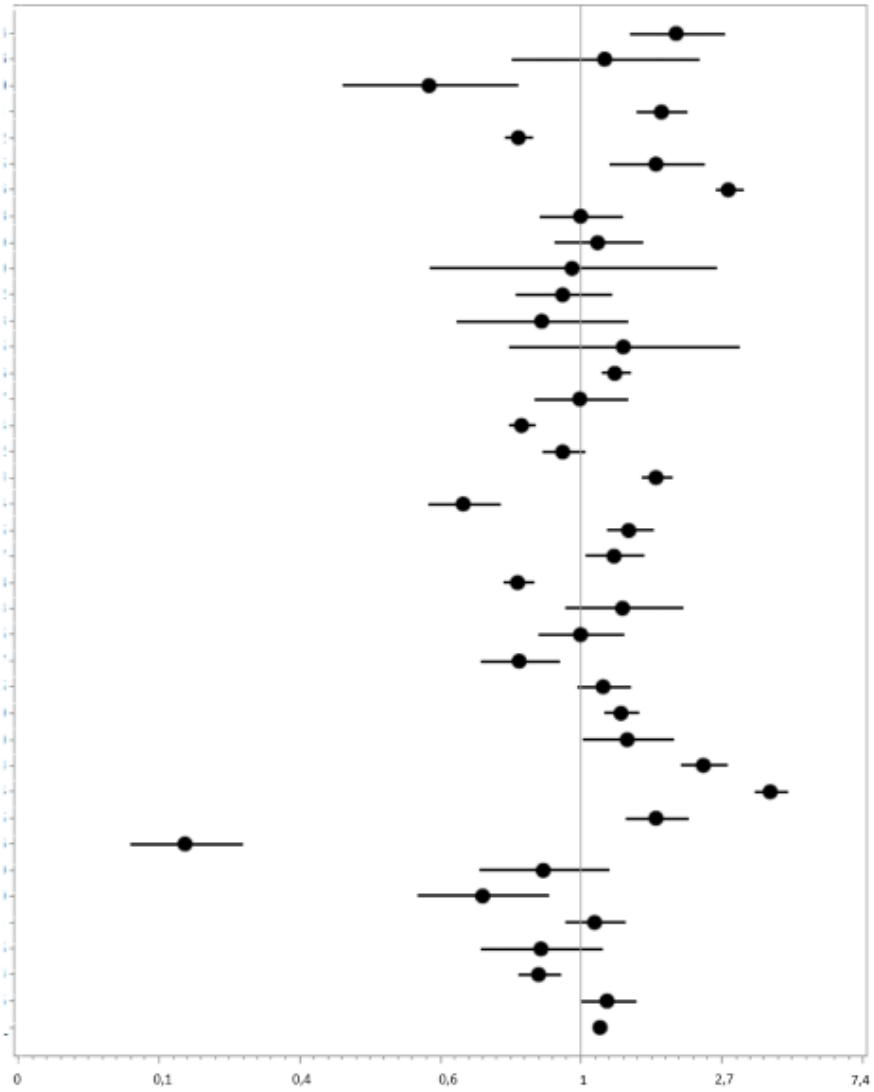


Figure 3 : Results of subgroup analysis

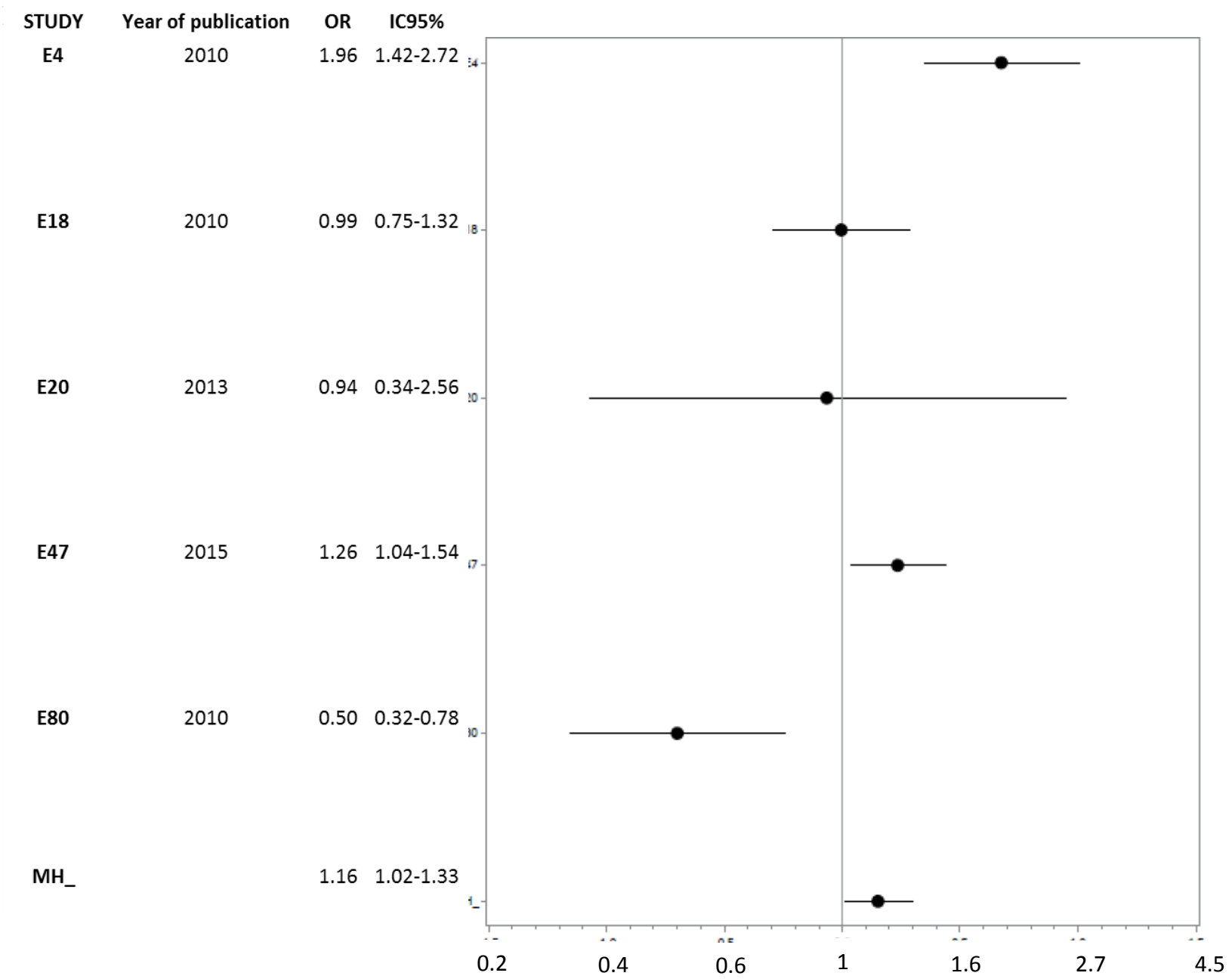


Figure 4: association between Mets and NCEP-ATPIII definition

Study	Year of publication	OR	CI95%
E9	2011	0.34	0.18-0.63
E11	2005	1.77	1.49-2.09
E12	2014	0.64	0.59-0.69
E16	2014	2.85	2.61-3.11
E19	2010	1.13	0.84-1.52
E22	2007	0.88	0.63-1.22
E23	2005	0.75	0.42-1.36
E25	2011	1.35	0.60-3.02
E34	2008	0.65	0.60-0.71
E45	2012	1.41	1.20-1.65
E53	2016	1.35	0.90-2.02
E55	2008	1.00	0.75-1.34
E57	2012	0.65	0.49-0.85
E65	2008	1.17	0.98-1.40
E69	2004	1.33	1.19-1.49
E70	2012	1.39	1.01-1.90
E73	2016	2.39	2.04-2.79
E74	2016	3.85	3.46-4.28
E76	2011	0.06	0.04-0.09
E79	2010	0.77	0.49-1.20
E81	2013	1.10	0.90-1.35
MH_		1.21	1.17-1.25

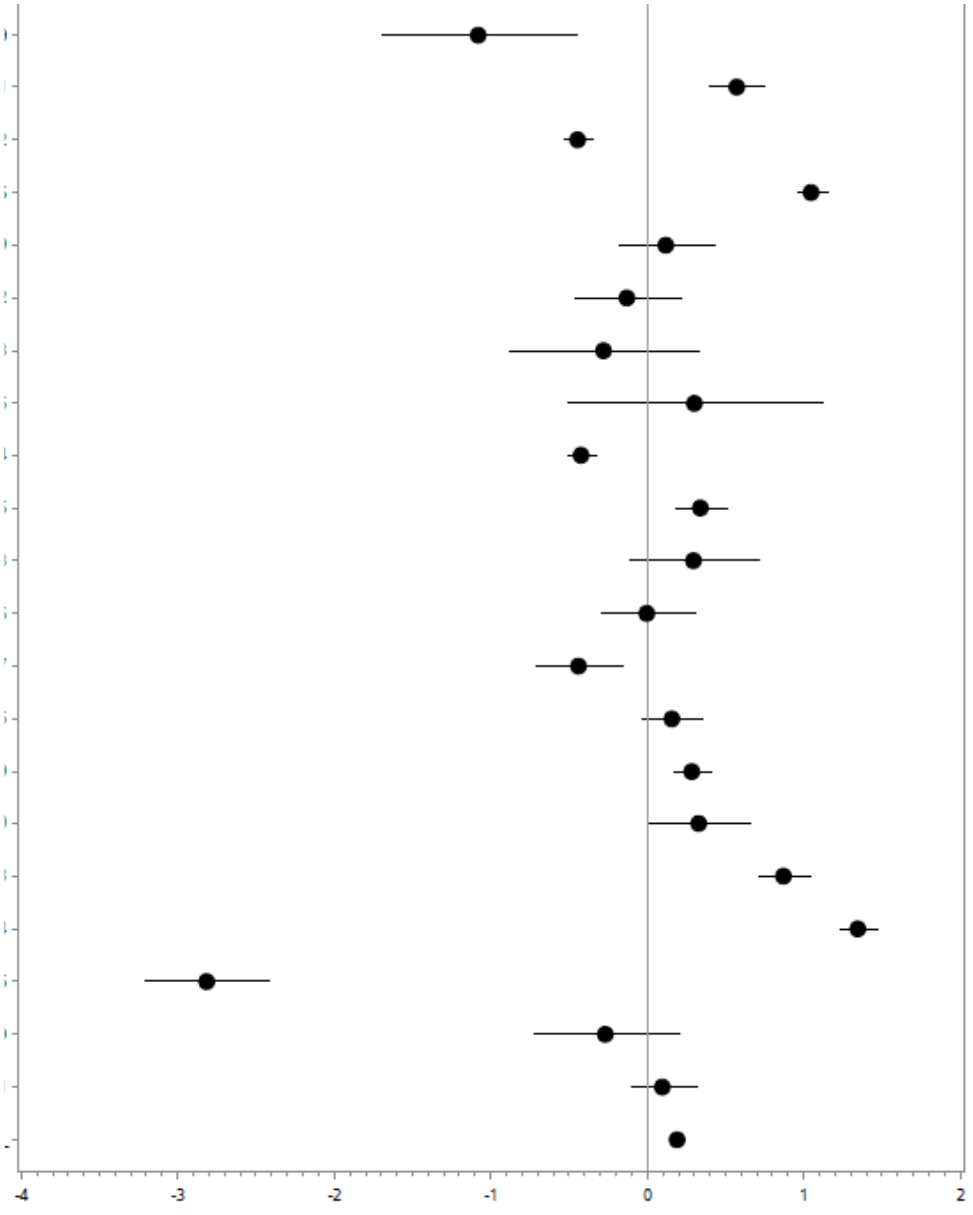
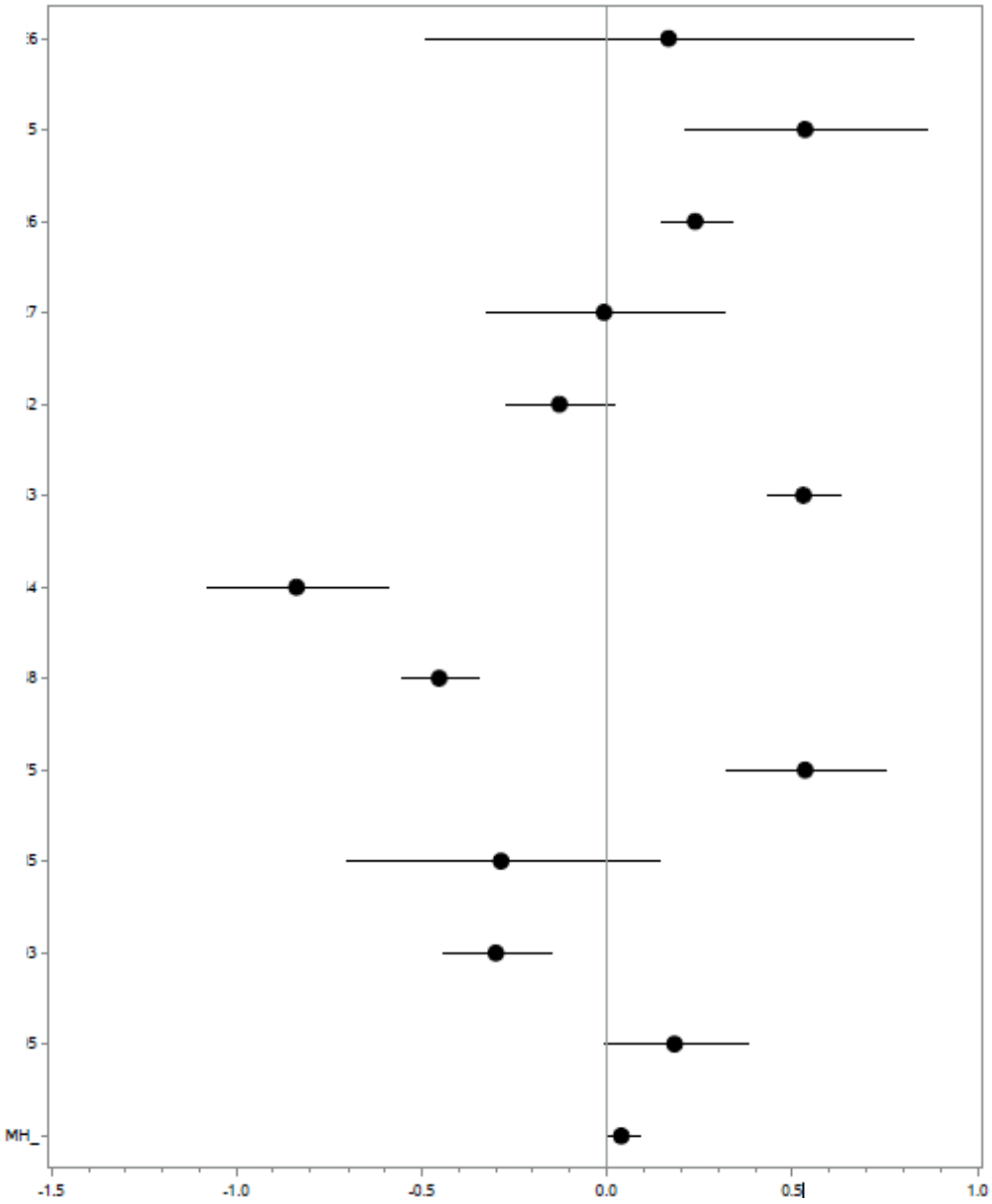
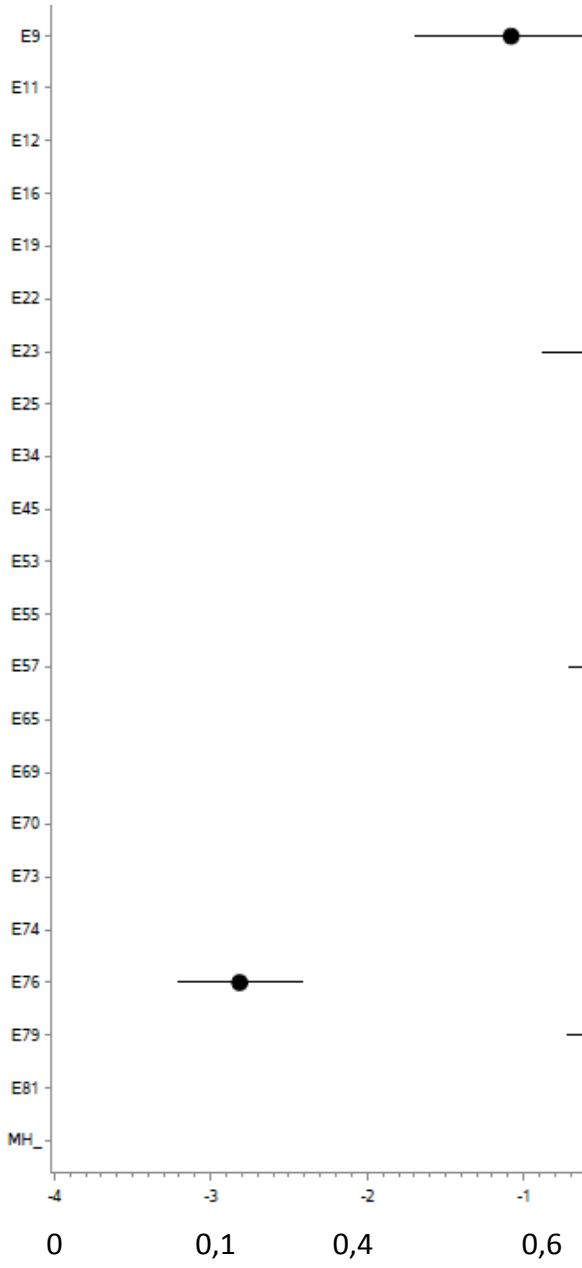


Figure 5 : association between Mets and other definitions

STUDY	Year of publication	OR	CI95%
E6	2016	1.18	0.61-2.27
E15	2013	1.71	1.23-2.36
E26	2015	1.27	1.16-1.39
E27	2016	0.99	0.72-1.36
E42	2008	0.88	0.76-1.01
E43	2007	1.70	1.54-1.87
E44	2014	0.43	0.34-0.55
E48	2014	0.64	0.58-0.70
E75	2006	1.71	1.38-2.11
E85	2012	0.75	0.49-1.14
E93	2009	0.74	0.64-0.64
E95	2010	1.20	0.99-1.45
MH_		1.04	1.00-1.09



Study	Year of publication	OR	CI95%
E9	2011	0.34	0.18-0.63
E11	2005	1.77	1.49-2.09
E12	2014	0.64	0.59-0.69
E16	2014	2.85	2.61-3.11
E19	2010	1.13	0.84-1.52
E22	2007	0.88	0.63-1.22
E23	2005	0.75	0.42-1.36
E25	2011	1.35	0.60-3.02
E34	2008	0.65	0.60-0.71
E45	2012	1.41	1.20-1.65
E53	2016	1.35	0.90-2.02
E55	2008	1.00	0.75-1.34
E57	2012	0.65	0.49-0.85
E65	2008	1.17	0.98-1.40
E69	2004	1.33	1.19-1.49
E70	2012	1.39	1.01-1.90
E73	2016	2.39	2.04-2.79
E74	2016	3.85	3.46-4.28
E76	2011	0.06	0.04-0.09
E79	2010	0.77	0.49-1.20
E81	2013	1.10	0.90-1.35
MH_		1.21	1.17-1.25



STUDY	Year of publication	OR	CI95%
E6	2016	1.18	0.61-2.27
E15	2013	1.71	1.23-2.36
E26	2015	1.27	1.16-1.39
E27	2016	0.99	0.72-1.36
E42	2008	0.88	0.76-1.01
E43	2007	1.70	1.54-1.87
E44	2014	0.43	0.34-0.55
E48	2014	0.64	0.58-0.70
E75	2006	1.71	1.38-2.11
E85	2012	0.75	0.49-1.14
E93	2009	0.74	0.64-0.64
E95	2010	1.20	0.99-1.45
MH_		1.04	1.00-1.09

