Table 1. Details of the included studies.

References	Country	Population	Subgroups	Mean age (SD)	n	% Female	Mean systolic blood pressure [mmHg (SD)]	Mean diastolic blood pressure [mmHg (SD)]	How BP measured	How CIMT measured	Relationship between BP and CIMT
Studies based on "normal" children recruited from the community											
Whincup et al (2012)	United Kingdom	UK primary-school children (school selection weighted to provide equal numbers of ethnic minorities)	Analysed as one group	10.8 (0.4)	939	52.7	104.4 (10.6)	63.2 (9.0)	Average of two-seated measurements in right arm after 5-minute rest using Omron 907	Left and right common carotid 1 cm proximal to bifurcation – 3 end-diastolic frames for each side analysed automatically to derive mean	Multilevel random effects model adjusted for sex, age, ethnicity, month, and random effect for school: each SD increase of systolic BP increased CIMT by 0.0024 mm (95% CI 0.0002–0.0046), each SD increase of diastolic BP increased CIMT by 0.0027 mm (95% CI 0.0005–0.0048)
Bohm et al (2009)	Germany	Healthy Munich school children	Analysed as one group	10 (IQR 8–13)	267	53.6	110 (IQR 100–118)	70 (IQR 63–75)	Two supine measurements in right arm after 15-minute rest	Measurements taken 8–18 mm proximal to bifurcation – automatically measured as mean of 11 measurements 1 mm part. This repeated three times on each side and overall mean calculated	SBP positively correlated with CIMT in both boys ($r = 0.31$, $p \leqslant 0.001$) and girls ($r = 0.24$, $p = 0.005$). DBP correlation not presented. Using multiple stepwise multiple linear regression analysis, SBP significantly associated with CIMT in boys but not girls ($\beta = 0.31$, $p \leqslant 0.001$), adjusted for height, weight, BMI, and body fat
Lim et al (2009)	Korea	All first-year students at a rural high school	Analysed as one group for initial correlations, then as top quartile of CIMT versus bottom three quartiles in logistic regression model	15.16 (0.41)	285	48.4	111.17 (12.43)	61.23 (6.98)	Average of two-seated automatic measurements	Automated measurement of CIMT of common carotid, carotid bulb, and proximal external and internal carotids. Maximum value calculated for each side then mean taken	Unadjusted Spearman's correlation positive association between SBP and CIMT ($r = 0.31$, $p \leqslant 0.01$) but not DBP Logistic regression (with having a top quartile IMT for sex as outcome) shows OR of 1.7 (95% CI 1.2–2.41) per SD of SBP increase, adjusted for age, sex, BMI, waist circumference, fasting plasma glucose, cholesterol. Effect of DBP not significant
Kollias et al (2013)	Greece	Healthy children recruited from five schools in one district	Analysed as one group	Boys: 13.8 (2.2) Girls: 14.2 (2.2)	448	52.9	Boys: 119.0 (12.7) Girls: 111.2 (10.5)	Boys: 72.1 (9.0) Girls: 70.5 (8.7)	Average of two-seated automatic measurements	1 cm section, proximal to carotid bulb, mean of three to four measurements on each side. Analysed as left and right separately and as mean of both	SBP significantly correlated with mean CIMT ($r = 0.14$, $p < 0.01$) Stepwise multivariate regression: SBP significantly associated with left (but not right or mean) CIMT ($\beta = 0.002$, $p < 0.01$). DBP not significantly associated with CIMT
Caserta et al (2010)	Italy	Random selection of children from school census list	Analysed as one group	Range 11–13, no further data given	642	50.6	105 (11.6)	65 (7.9)	Average of two-seated measurements after 10-minute rest	Average of three measurements of common carotid 0.5, 1 and 1.5 cm proximal to bifurcation	In univariate linear regression both SBP and DBP significantly associated with CIMT ($\beta = 0.0006$, $p < 0.001$ and $\beta = 0.0005$, $p = 0.006$, respectively). In multivariate linear regression SBP but not DBP significantly associated with CIMT ($\beta = 0.0004$, $p = 0.005$), after adjusting for presence of fatty liver disease, BMI, waist circumference, AlT, GGT, HDL cholesterol, and CRP
Mittelman et al (2010)	United States of America	Healthy subjects recruited from schools and universities from a single county	Analysed both as one single group, and as a healthy weight (BMI <85th centile) group alone	14.6 (3.7)	599	51.3	107.7 (10.0)	58.6 (6.6)	Average of two manual supine readings from each arm, after 10-minute rest	Average of three systolic and three diastolic automated measurements on left side	SBP significantly correlated with CIMT in boys and girls ($r = 0.17$, $p = 0.043$, $r = 0.16$, $p = 0.0062$, respectively). DBP not correlated. When the group with "healthy" weights (BMI <85th centile), are analysed separately, SBP is only correlated with CIMT in boys ($r = 0.15$, $p = 0.0364$) In multiple regression models, BP is not significantly associated with CIMT, either in the group as a whole or the isolated healthy weight group
Sarkola et al (2012)	Cananda	Healthy children recruited from local public schools, and from low-risk (cardiac murmur) cardiology clinic once cardiac disease excluded	Analysed as one group	Not stated	135	41.5	Overall average not presented	Overall average not presented	Mean of the lowest two of three supine readings in each limb, after 30-minute rest	Mean of three manual measurements 1 cm proximal to the carotid bulb	In both univariate and multivariate regression analyses, SBP significantly associated with CIMT ($\beta = 3.1$, $p < 0.001$ and $\beta = 1.1$, $p = 0.03$, respectively). Multiple regression model adjusts for gender, age, and BSA
Ishizu et al (2004)	Japan	Study population recruited from a single school in rural Japan	Analysed as one group	11 (2)	60	45	108 (13)	64 (11)	Radial blood pressure measured in right forearm	Automated measurements of two images 1–2 cm proximal to carotid bulb	After adjustment for age only in multivariable linear regression models, SBP is not significantly associated with mean CIMT, however, DBP is significantly associated ($r = 0.46$, $p = 0.049$). In a larger model adjusting for gender, parental smoking, BMI, age, and serum lipids, neither SBP nor DBP are significantly associated with CIMT

Studies based on children identified as hypertensive, either from clinic or following population screening (± a normotensive comparison group)

Stabouli et al (2012)	Greece	Children referred to secondary care for investigation of possible hypertension (those with secondary hypertension excluded)	Split into obese and non-obese groups for analysis	13.7 (4.1) for non-obese 12.7 (4.0) for obese	128	Not presented	116.6 (12.0) for non-obese 122.3 (13.2) for obese	68.7 (7.5) for non-obese 69.0 (8.7) for obese	Measured both 24-hour ambulatory BP (measurement every 15–30 minutes using Spacelabs 90,217) and one-off "clinic" BP (mean of three-seated measurements after 5-minute rest)	Left and right common and internal carotid, 1 cm from bifurcation, mean of 10 measurements of each side	Using Pearson's correlation both clinic SBP and DBP positively associated with CIMT for both common carotid ($r = 0.41$ and 0.32, respectively) and internal carotid ($r = 0.33$ and 0.30, respectively). 24-hour SBP correlated with CIMT ($r = 0.29$ for common carotid and 0.23 for internal). 24-hour DBP not significantly associated Using ANCONA analysis, after adjusting for age and obesity, neither clinic nor 24-hour BP remained significantly associated with either CIMT measurement
Pall et al (2010)	Hungary	Healthy adolescent students included in the Debrecen hypertension study, recruited from local secondary schools	Students screened for hypertension based on height and weight centiles (>90th centile treated as hypertension), then used ambulatory BP monitoring to further divide into "white-coat" and "sustained" hypertension. A 3rd "normotensive" group included to act as a comparator	Normotensive: 15.8 (0.6) White-coat hypertensives: 16.3 (1.1) Sustained hypertensives: 16.5 (1.0)	179	48.0	Normotensive: 114.9 (10.0) White-coat hypertensives: 138.3 (11.4) Sustained hypertensives: 144.8 (11.1)	Normotensive: 66.8 (8.9) White-coat hypertensives: 82.5 (11.0) Sustained hypertensives: 82.4 (8.3)	Single BP measured as average of three-seated right arm measurements 5 minutes apart. 24-hour ambulatory measurement measured every 15–30 minutes for 24 hours from 8–9 am	Measurements taken 2 cm proximal to flow divider between internal and external carotids. Average of three images on each side	CIMT in both white-coat and sustained hypertensives significantly higher than normotensive controls when compared by t-test (0.056 mm and 0.054 mm, respectively versus 0.048 mm, both $p \leqslant 0.001$). No significant difference between the two hypertensive groups
Gil et al (2008)	Korea	Hypertensive children identified after screening school children (SBP >140 mmHg or DBP >90 mmHg), and normotensive controls (not mentioned how recruited)	Analysed as one group	Mean age not presented. Range 16–18 years	32	18.8%	Hypertensive group: 148.1 (6.5) Normotensive group: 115.9 (15.9)	Hypertensive group: 73.3 (8.0) Normotensive group: 72.6 (10.5)	Average of three automatic measurements after 5-minute rest	CIMT measured 1 cm proximal to the bifurcation of the right common carotid	Unadjusted CIMT greater in hypertensive versus controls (0.62 versus 0.50 mm, $p < 0.05$), compared by t-test
Lande et al (2006)	United States of America	Newly diagnosed untreated hypertensive children recruited from hypertension or nephrology clinics, hypertension confirmed by three readings >95th centile for age, sex and height, and also ABPM daytime and/or night-time average >95th centile for sex and height norm. Secondary and white-coat hypertension excluded. Age, sex and BMI-matched healthy controls recruited from a general paediatric clinic	Analysed both as two separate groups and as one combined group	Hypertensive group: 14.9 (2.3) Controls: 14.6 (2.1)	56	21	Hypertensive group: 144 (12) Controls: 120 (8)	Hypertensive group: 77 (10) Controls: 64 (8)	Office BP measurement method not described. ABPM also performed in known hypertensive group, measured every 20–30 minutes for 24 hours	Measured 1 cm proximal to the bifurcation on left side, average of three measurements	Average CIMT higher in hypertensive group compared with controls (0.67 versus 0.63 mm, respectively, $p = 0.45$). No significant correlation between office BP and CIMT, but significant correlation seen between ABPM parameters in hypertensive group and CIMT, e.g.: daytime systolic index ($r = 0.57$, $p = 0.03$), daytime mean SBP ($r = 0.43$, $p = 0.03$)
Litwin et al (2006)	Poland	Newly diagnosed untreated children with essential hypertension referred to secondary care. Healthy control group recruited from schools	Analysed both as two separate groups (also splitting by sex) and as one combined group	Hypertensive boys: 14.6 (2.9) Hypertensive girls: 14.1 (2.8) Control boys: 14.1 (3.6) Control girls: 13.5 (4.0)	175	Hypertensive: 30.6 Control: 44.7	Hypertensive boys: 140 (12) Hypertensive girls: 131 (13) Control boys: 117 (11) Control girls: 111 (10)	Hypertensive boys: 63 (8) Hypertensive girls: 64 (14) Control boys: 57 (7) Control girls: 59 (8)	BP measurement method not described	Method described in previous paper: five to six measurements 1–2 cm proximal to bifurcation on each side, average taken	CIMT significantly higher in hypertensive patients versus controls in both boys (0.47 versus 0.43, respectively, $p = 0.0001$) and girls (0.47 versus 0.41, $p = 0.0001$). Stepwise linear regression: BP not significant in model as predictor of CIMT
Sorof et al (2003) (Pediatr)	United States of America	Newly diagnosed untreated hypertensive childrens referred to a secondary-care hypertension clinic	Analysed as one group	13.9 (2.7)	32	21.9	138 (10)	77 (9)	Automatic measurement after 5-minute rest	Maximum thickness of IMT 2 cm proximal to flow divider of common carotid on both sides	CIMT not correlated with BP values. Subjects in upper quartile of CIMT values did not have a significantly difference BP compared with those in the bottom three quartiles
Loureiro et al (2013)	Chile	Hypertensive children (defined as SBP/DBP >90th centile for sex, age and height) recruited from hospital	Analysed as one group	Median: 11.2 (SD not stated, IQR = 4.2)	64	39	Actual SBP not presented, only SBP index (= observed BP/ 50th centile value for age, sex, and height).	Median DBP index: 1.27 (IQR = 0.20)	Mean of three-seated automatic measurements in the right arm	Measured in a 1 cm segment within the bifurcation on each side, used automatic border-detection software	SBP index and DBP index significantly correlated with CIMT ($r = 0.323$, $p < 0.01$ and $r = 0.304$, $p < 0.05$, respectively) In a multiple linear regression model adjusting for BMI, serum aldosterone, and angiotensin/renin

Table 1. *Continued*

References	Country	Population	Subgroups	Mean age (SD)	n	% Female	Mean systolic blood pressure [mmHg (SD)]	Mean diastolic blood pressure [mmHg (SD)]	How BP measured	How CIMT measured	Relationship between BP and CIMT
		nephrology and endocrinology clinics. Excluded those with diabetes, renal disease, liver disease, etc.					Median SBP index: 1.17 (IQR = 0.13)				ratio, neither SBP index nor DBP index are significantly associated with CIMT
Sorof et al (2003) (Pediatr nephrol)	United States of America	Hypertensive children (SBP or DBP >95th centile for age, gender and height) recruited from both hypertension clinic, and a school-based BP screening study. Control normotensive subjects recruited from a school-based study	Analysed as one group	Hypertensive group: 13.8 (2.6) Normotensive group: 12.1 (0.9)	86	33.7	Hypertensive group: 139 (10) Normotensive group: 113 (7)	Hypertensive group: 77 (9) Normotensive group: 69 (4)	Mean of three-automated seated measurements	Mean of two measurements on each side, 1 cm apart, first of which within 1 cm of carotid bulb	Overall, hypertensive subjects had greater CIMT compared with normotensives (0.62 versus 0.53 mm $p < 0.0001$). This effect remained when subjects were split into BMI overweight/normal weight groups. Using simple linear regression, both SBP and DBP were significantly positively associated with CIMT ($r = 0.3$, $p = 0.001$ and $r = 0.22$, $p = 0.044$, respectively) In multiple linear regression adjusting for age and BMI, SBP was no longer associated with CIMT (DBP not included in model)
Studies based on children identified as overweight or obese, either from clinic or following population screening (± a normal BMI comparison group)											
Rheinehr et al (2007)	Germany	Consecutive patients from the outpatient obesity clinic. Those with metabolic, endocrine, or genetic disorders, or on medical therapy were excluded	Analysed as one group	11 (IQR = 4)	264	56.9	119 (15)	64 (12)	Average of two supine measurements from right arm after 10-minute rest	Measured "near" bifurcation, maximum value of four values on each side used	Multiple linear regression adjusting for age and sex only: increase of 0.00018 and 0.00013 mm CIMT per increase of 1 mmHg in SBP and DBP, respectively ($p < 0.0001$ and 0.0104, respectively)
Hacihamdioglu et al (2011)	Turkey	Consecutive patients recruited from hospital obesity clinic. Also healthy age, sex, and pubertal stage-matched controls (not specified where controls recruited from)	Relationship between BP and CIMT analysed in obese group only	Obese: 9.3 (2.5) Control: 9.3 (2.8)	134	37.3	Obese: 114.9 (6.7) Controls: 109.3 (10.8)	Obese: 69.4 (8.1) Controls: 70.5 (5.7)	Measured using mercury sphygmomanometer after 10-minute rest	Mean of three measurements of maximum wall thickness 10 mm proximal to carotid bulb	In obese group, CIMT significantly correlated with SBP ($r = 0.19$, $p = 0.04$) but not DBP In "linear logistic" regression, BP not significantly associated with CIMT
Ozcetin et al (2012)	Turkey	Obese children recruited from secondary care obesity clinic. Control group of "similar" age and sex distribution without obesity recruited (not specific how or where from)	Analysed as one group	Obese group: 10.12 (2.12) Control group: 9.78 (1.78)	78	58.9	Obese: 110 (IQR = 15) Control 90 (IQR 5)	Obese: 90 (IQR = 5) Control: 60 (IQR = 5)	Average of two readings	Measurement technique not presented	Analysing all subjects together, SBP significantly correlated with CIMT ($r = 0.306$, $p < 0.05$), DBP not correlated
Casariu et al (2011)	Romania	Obese and non-obese children recruited – not specified how or where from. Those taking medications or with "chronic disease" excluded	Relationship between BP and CIMT analysed in obese group only	Obese group: 12.6 (3.1) Control group: 12.6 (3.1)	100	58	Obese: 108.7 (5.08) Control: 96.59 (5.2)	Obese: 66.8 (4.06) Control: 59.25 (2.6)	Average of two automatic supine measurements in right arm after 10-minute rest	Mean of three maximum thickness measurements, "near" bifurcation	Both SBP and DBP significantly correlated with CIMT ($r = 0.51$ and 0.41, respectively, p both <0.05)
Simsek et al (2010)	Turkey	Obese and non-obese control subjects (not specified how or where either group recruited)	Analysed as one group	Obese: 10.8 (2.03) Control: 10.9 (2.11)	115	46.1	Obese: 113 (SD not presented) Control: 98 (SD not presented)	Obese: 84 (SD not presented) Control: 62 (SD not presented)	Average of two supine manual measurements in right arm after 10-minute rest	Maximum of four measurements on each side, 10 mm proximal to the bifurcation	DBP centile significantly correlated with CIMT ($r = 0.42$, $p < 0.001$). SBP not correlated. In multivariable linear regression, neither SBP nor DBP significantly associated with CIMT
Fang et al (2010)	China	Obese and non-obese children recruited as controls (not specified where or how). Obese children further subdivided into those with and without metabolic syndrome	Analysed as one group	Obese: 10.5 (1.6) Control: 11.1 (2.1)	108	21.3	Obese without metabolic syndrome: 111.67 (SD not given) Obese with metabolic syndrome: 122.3 (SD not given) Controls: 103.32 (SD not given)	Obese without metabolic syndrome: 67.06 (SD not given) Obese with metabolic syndrome: 70.91 (SD not given) Controls: 63.14 (SD not given)	Average of two automatic supine measurements in right arm after 10-minute rest	Mean of three measurements of maximum thickness along a 1 cm segment proximal to the carotid bulb	Both SBP and DBP significantly correlated with CIMT ($r = 0.27$, $p = 0.006$ and $r = 0.21$, $p = 0.033$, respectively) In stepwise multiple linear regression, neither SBP nor DBP significantly associated with CIMT after adjustment

Yilmazer et al (2010)	Turkey	Obese children (BMI >90th centile for age) recruited from paediatric cardiology clinic (reason for attending clinic not specified). Control subjects recruited from group investigated for physiological murmur. Secondary causes of obesity excluded	Relationship between CIMT and BP analysed in obese group only	Obese group median: 11.5 (SD not stated, range 7–15.5) Non-obese group median: 9.75 (SD not stated, range 7–16)		Obese group: 46.8 Non-obese group: 42.5	Obese group median: 115 (SD not presented, range 80–170) Non-obese group median: 100 (SD not presented, range 80–120)	Obese group median: 75 (SD not presented, range 50–100) Non-obese group median: 70 (SD not presented, range 50–80)	One measurement using manual sphygmomanometer after 10-minute rest	Average of three measurements from right common carotid, 20 mm proximal to carotid bulb	In obese children, CIMT is positively correlated with both DBP ($r = 0.32$, $p = 0.005$) and SBP ($r = 0.38$, $p = 0.001$). In stepwise multiple linear regression, neither SBP nor DBP were significantly associated with CIMT
Elkiran et al (2013)	Turkey	Healthy subjects recruited from random selection of primary schools in one city (not clear how study population selected from overall population). Split into obese, overweight, and control groups based on BMI	Relationship between BP and CIMT analysed in obese group only	Obese group: 13.3 (0.86) Overweight: 13.2 (0.69) Control: 11.1 (0.72)	123	54.5	Obese: 116.4 (11.6) Overweight: 114.6 (9.5) Control: 98.8 (11.7)	Obese: 74.5 (8.6) Overweight: 73.3 (7.1) Control: 64.2 (7.4)	Average of two supine readings from right arm, after 10-minute rest	Left common carotid, exact site or measurement technique not specified	In the obese group only, DBP is significantly correlated with CIMT ($r = 0.266$, $p = 0.03$). With multiple linear regression, again in obese group only, DBP is significantly associated with CIMT ($\beta = 0.301$, $p = 0.031$) after adjustment for SBP, BMI, waist circumference, fat mass, and CRP. Data not shown for associations between BP and CIMT in overweight or control groups
Leite et al (2012)	Portugal	Obese and overweight children recruited from hospital paediatric obesity clinic. Normal-weight control group recruited from same hospital, with "non-organic" disease e.g., ADHD, learning disability	Analysed as one group	Obese group: 13.3 (2.3) Overweight group: 12.7 (2.1) Normal weight group: 12.8 (2.5)	150	Obese group: 52 Overweight group: 44 Normal weight group: 46	Obese group: 118.9 (14.8) Overweight group: 112.8 (12.0) Normal weight group: 108.2 (9.8)	Obese group: 73.6 (9.4) Overweight group: 68.5 (8.0) Normal-weight group: 61.5 (8.9)	Mean of three automated measurements in the right arm after 10-minute rest	Mean of three measurements on each side of common carotid 1 cm proximal to carotid bulb	In simple correlation, DBP significantly positively associated with CIMT ($r = 0.266$, $p = 0.001$), SBP not associated (data not presented) In multiple linear regression adjusting for waist circumference and BMI, DBP was no longer significantly associated with CIMT
Miscellaneous studies											
Tamura et al (2011)	Japan	Healthy children seen at a hospital for a "health check-up"	Analysed as one group	9.5 (2.7)	52	33.3	112.8 (12.3)	55.5 (7.9)	Single-seated measurement after 15-minute rest	Common carotid, measurement of three thickest areas on each side (exact site not specified). Mean taken of these measurements	DBP positively correlated with CIMT in girls only ($r = 0.563$ $p = 0.045$). SBP not correlated with CIMT in boys or girls. Using stepwise multiple linear regression, no association seen between BP and CIMT
Krebs et al (2009)	Germany	Consecutive patients seen in paediatric hospital clinic for hypercholesterolaemia, and a separate group of "healthy" children (not specified where recruited from)	Hypercholesterolaemic and "control" groups analysed separately	Hypercholesterol-aemia group: 11.2 (SD not given, range 5.8–17.9) "Control" group: 12.4 (SD not given, range 7.1–17.6)	100	53.0	Hypercholesterolaemia group: 110 (SD not given, range 90–145) "Control" group: 110 (SD not given, range 100–139)	Hypercholesterolaemia group: 70 (SD not given, range 37–90) "Control" group: 110 (SD not given, range 56–90)	At least three measurements taken using a mercury sphygmomanometer	CIMT measured along a 1 cm segment of common carotid "just before" carotid bulb. Automatic measurement of 100–111 points along segment, average of each side	In children with normal cholesterol, those with SBP >90th centile compared with population norms had mean CIMT not significantly different to those with BP <90th centile (0.542 versus 0.546 mm $p = 0.91$) In hypercholesterolaemic children, those with SBP >90th centile had significantly greater CIMT compared with those with SBP <90th centile (0.594 versus 0.545 mm, $p = 0.006$) Also analysed using Spearman's correlation of SBP index (average SBP divided by 90th centile based on age, sex and height) with CIMT. In hypercholesterolaemic children significant correlation seen ($r = 0.358$, $p = 0.001$). No significant correlation seen in "control" children
Yang et al (2007)	China	Not specified where or how subjects recruited	Split into two groups based on age (five to nine years, 10–18 years)	9.7 (3.0)	79	Not presented	Overall mean not presented	Overall mean not presented	BP measurement method not described	Distal 1–1.5 cm of right and left common carotid. Maximal thickness recorded	Analysed in two separate age groups: five to nine years and 10–18 years. Within in age group, split into "normal" and "abnormal" CIMT groups, based on values from a previous study. In the younger age group, no significant difference in SBP or DBP in the normal versus abnormal CIMT groups. In the older age group, both SBP and DBP significantly higher in the abnormal CIMT groups (SBP: 116.8 versus 103.5, $p = 0.001$, DBP 77.4 versus 68.5, $p = 0.01$)

SBP, DBP, BMI, IMT, AlT, GGT, HDL, chol, CRP, ANCONA, ABPM, IQR, ADHD, BSA, DSP