Supplementary Appendix

This appendix has been provided by authors to give readers additional information about their work.

Supplement to: Vitamin D status in Mainland of China: a systematic review and meta-analysis.

Contents

Supplementary file 1: Search strategy

1. PubMed

Access Date: 4 Jun 2021

Search strategy:

("vitamin d"[MeSH Terms] OR "ergocalciferols"[MeSH Terms] OR "ergocalciferols"[MeSH Terms] OR "calcifediol"[MeSH Terms] OR "cholecalciferol"[MeSH Terms] OR "vitamin d deficiency"[MeSH Terms] OR "vitamin d"[Title/Abstract] OR "25 hydroxyvitamin d"[Title/Abstract] OR "calcifediol"[Title/Abstract] OR "ergocalciferols"[Title/Abstract] OR "cholecalciferol"[Title/Abstract] OR "vitamin d deficiency"[Title/Abstract]) AND ("china"[MeSH Terms] OR "china"[All Fields] OR "china s"[All Fields] OR "chinas"[All Fields] OR "china"[MeSH Terms] OR "asian continental ancestry group"[MeSH Terms] OR ("asian continental ancestry group"[MeSH Terms] OR ("asian"[All Fields] AND "continental"[All Fields] AND "ancestry"[All Fields] AND "group"[All Fields]) OR "asian continental ancestry group"[All Fields] OR "chinese"[All Fields] OR "chineses"[All Fields]))

Search Results: 5197

2. Web of Science

Access Date: 4 Jun 2021

Search strategy:

3	1 AND 2 Databases= WOS, Time span=All years, Search language=Auto	2943
2	TS= (China OR Chinese) Databases= WOS, Time span=All years, Search language=Auto	1094501
1	TS=(vitamin D OR vitamin D deficiency OR 25-hydroxyvitamin D OR calcifediol OR ergocalciferols OR cholecalciferol) Databases= WOS, Time span=All years, Search language=Auto	116123

3. EMBASE

Access Date: 4 Jun 2021

Search strategy:

18	(1 or 2 or 3 or 4 or 5 or 6 or 10 or 11 or 12 or 13 or 14 or 15) and (8 or 9 or 16 or 17)	2308
17	Chinese.ab,kw,ti,tw.	300585
16	China.ab,kw,ti,tw.	253237
15	cholecalciferol.ab,kw,ti.	4651
14	ergocalciferols.ab,kw,ti.	14
13	calcifediol.ab,kw,ti.	341
12	25-hydroxyvitamin d.ab,kw,ti.	17418
11	vitamin d deficiency.ab,kw,ti.	23315
10	vitamin d.ab,tw,ti.	100329
9	China/	235790
8	Chinese/	66293
7	China/ep[Epidemiology]	8276
6	colecalciferol/	22009
5	ergocalciferol/	8796
4	calcifediol/	9360
3	25 hydroxyvitamin D/	23525
2	vitamin D deficiency/	32391
1	vitamin D/	81078

4. China National Knowledge Infrastructure (CNKI)

Access Date: 4 Jun 2021

Subject category: Medicine & Public Health

Sub-database: Journal articles, Dissertations

Search strategy:

(SU="维生素 D") AND (SU="缺乏" + "水平" + "调查" + "流行" + "现状" + "现况")

Search Results: 3783

5. WanFang

Access Date: 4 Jun 2021

Subject category: Medicine & Public Health

Sub-database: Journal articles, Dissertations

Search strategy:

题名或关键词:(("维生素D") and ("缺乏" or "水平" or "调查" or "流行" or "现状" or "现况"))

Search Results:3594

6. VIP

Access Date: 4 Jun 2021

Subject category: Medicine & Public Health

Search strategy:

M=(("维生素 D") AND ("缺乏" or "水平" or "调查" or "流行" or "现状" or "现况"))

Search Results:2002

Supplementary file 2: Hierarchical Bayesian model and the code from R software

1. The Hierarchical Bayesian model

Meta-analysis usually combines aggregated or individual results from several studies to create a pooled, more precise estimate of an effect. Due to the hierarchical structure (intra-study and between-study) of meta-analysis data, the hierarchical Bayesian approach is often used in meta-analysis. Meanwhile, the Bayesian approach allows us to account for uncertainty from the varying quality of data and borrow strength from non-missing data, and MCMC sampling allows for inference in a high-dimensional, constrained parameter space, while providing posterior estimation that allow straightforward inference on the wide variety of functionals of interest.

In our meta-analysis, the outcomes of interest were the prevalence of vitamin D (VitD) deficiency (<30 nmol/L, or < 12 ng/mL), VitD inadequacy (<50 nmol/L, or < 20 ng/mL), and mean serum 25(OH)D concentration (nmol/L).We use the Hierarchical Bayesian models to estimate the pooled prevalence of VitD deficiency, inadequacy and mean serum 25(OH)D concentration.

For the *i*th study which reported the dichotomous outcomes, the number of populations with VitD deficiency/ inadequacy in the *i*th study followed the binomial distribution:

$$r_i \sim \text{binomial}(n_i, p_i) \qquad (1)$$

Where n_i was the total number of investigated population and p_i was the true prevalence of VitD deficiency/ inadequacy for the *i*th study.

The logit transformation of p_i followed a normal distribution among studies:

$$\theta_i = logit(p_i) \sim \text{normal}(\mu, \sigma^2) \qquad (2)$$

Where μ was the mean of logit(p_i) and σ^2 was the between-study variance.

r_i and n_i were extracted from each study, θ_i , μ and σ^2 were parameters estimated from the model.

And we could estimate the pooled prevalence of VitD deficiency/ inadequacy and the

corresponding 95% credible interval (CrI) through retransform the :

$$prevalence = exp(\mu)/(1 + exp(\mu)) \quad (3)$$

For the *i*th study which reported the mean of VitD concentration ($mean_i$), $mean_i$ followed a normal distribution:

$$mean_i \sim \text{normal}(\theta_i, S_i^2) \quad (4)$$

Where θ_i was the true value of the VitD concentration in the *i*th study and S_i was standard error of the estimated $mean_i$.

θ_i followed a normal distribution among studies:

$$\theta_i \sim \text{normal}(\mu, \sigma^2) \quad (5)$$

Where μ was the pooled mean of the vitamin D concentration and σ^2 was the between-study variance.

The $mean_i$ and se_i were extracted or calculated from each study, θ_i, μ and σ^2 were parameters estimated from the model.

The hierarchical model also called the random-effect model or mixed-effect model. In the above models, (1) and (4) were the within-study component of hierarchical model, (2) and (5) were between-study component, the study-specific and the pooled parameters can estimate from the hierarchical model.

2. The Hierarchical Bayesian meta-regression model

2.1 Study-level covariates

To assess the effects of sampling frame, latitude, urbanization, season, assays for serum 25(OH)D on the outcomes (prevalence of VitD inadequacy and mean concentration of VitD), we constructed the Hierarchical Bayesian meta-regression model for each study-level covariate separately.

In the within-study level, the models were the same as formula (1) or (4).

In the between-study level, let X_i stand for the vector of covariates of the *i*th study and α stand for the constant term. θ_i was the true value of logit transformation of prevalence of VitD inadequacy, or true value of the vitamin D concentration from the *i*th study, and $\alpha + X_i\beta$ predict the θ_i with residual variance, which followed a normal

distribution:

$$\theta_i = \alpha_i + \sum \beta_p X_{pi} \quad (6)$$

$$\alpha_i \sim \text{normal}(\mu, \sigma^2) \quad (7)$$

The model included the random intercept and fix effect of the slope. From the model, we obtained the pooled prevalence of VitD inadequacy or mean concentration in each level of the specific covariate and the ratio or difference between two levels of the specific covariate.

For "sampling frame", we specified x1=1 as the study sampled with province or city level, x2=1 as the study sampled with county level, and the study sampled national wide as the reference (constant).

Table A. Data structure of VitD inadequacy with the study-level covariate

Study(i)	Sampling frame	$x1_i$	$x2_i$	n_i	r_i
1	National	0	0	…	…
2	Province or City	1	0	…	…
3	County	0	1	…	…
4	…		0	…	…
…	…		…	…	…

When estimated the prevalence of VitD inadequacy, according to formulas (1), (6), (7), we obtained the pooled prevalence of VitD inadequacy when studies sampled from National, Province or City, County respectively:

$$\text{Prevalence (National)} = exp(\mu)/(1 + exp(\mu)) \quad (8)$$

$$\text{Prevalence (Province or City)} = exp(\mu + \beta_1)/(1 + exp(\mu + \beta_1)) \quad (9)$$

$$\text{Prevalence (County)} = exp(\mu + \beta_2)/(1 + exp(\mu + \beta_2)) \quad (10)$$

And the Odds Ratio:

$$\text{Odds Ratio (Province or City vs. National)} = exp(\beta_1) \quad (11)$$

$$\text{Odds Ratio (County vs. National)} = exp(\beta_2) \quad (12)$$

$$\text{Odds Ratio (Province or City vs. County)} = exp(\beta_1 - \beta_2) \quad (13)$$

When estimate the mean concentration, according to the formulas (4), (6), (7), we can obtain the pooled mean concentration of VitD inadequacy when studies sampled from National, Province or City, County respectively:

$$\text{Mean concentration (National)} = \mu \quad (14)$$

$$\text{Mean concentration (Province or City)} = \mu + \beta_1 \quad (15)$$

$$\text{Mean concentration (County)} = \mu + \beta_2 \quad (16)$$

And the difference of concentration (nmol/L):

$$\text{Difference (Province or City vs. National)} = \beta_1 \quad (17)$$

$$\text{Difference (County vs. National)} = \beta_2 \quad (18)$$

$$\text{Difference (Province or City vs. County)} = \beta_1 - \beta_2 \quad (19)$$

If the 95%CrI of the effect size (odds Ratio or difference) estimated from the HB meta-regression models included the null effect size of 1 or 0, then this covariate was not considered as the factor causing the heterogeneity of studies.

The same calculation process was applied for other covariates. And the specifications for other study-level covariates were as follow:

For “latitude”, x1=1 indicated the study sampled from north areas only, x2=1 indicated the study sampled from both the south and north areas, and the study sampled from south areas only as the reference (constant). For “urbanization”, x1=1 indicated the study sampled from rural areas only, x2=1 indicated the study sampled from both urban and rural areas, and the study sampled from urban areas only as the reference (constant). For “season”, x1=1 indicated the VitD measured during summer-autumn, x2=1 indicated the VitD measured covering at least a whole year, and the VitD measured during winter-spring as the reference (constant). For “assays”, x1=1 indicated the VitD measured using the ELISA (Enzyme-linked immunosorbent assays), x2=1 indicated the VitD measured using the ECLIA (Electrochemiluminescence immunoassay), x3=1 indicated the VitD measured using CLIA (Chemiluminescent assay) ,x4=1 indicated the VitD measured using the RIA (Radioimmunoassay) ,and the chemical assays including HPLC (High-performance liquid chromatography) and LC-MS/MS (Liquid chromatography coupled with mass

spectrometry) as the reference (constant).

2.2 Sex difference and Age trend

We could extract the sex-specific or age-specific outcomes from most of the included studies, but few studies provided the sex- and age-specific outcomes. As a result, we constructed the Hierarchical Bayesian meta-regression model for sex-specific and age-specific outcomes separately.

Table B listed the data structure of the sex-specific VitD inadequacy. Each row indicated a study-sex group, and sex=0 indicated male and sex=1 indicated the female.

Table B. Data structure of the sex-specific VitD inadequacy

Study-sex(ij)	Study(j)	Sex_{ij}	n_{ij}	r_{ij}
1	1	1	…	…
2	1	0	…	…
3	2	1	…	…
4	2	0	…	…
…	…	…	…	…

In the ij study-sex group, r_{ij} followed the binomial distribution:

$$r_{ij} \sim \text{binomial}(n_{ij}, p_{ij}) \quad (1)$$

The logit transformation of p_{ij}, which was the θ_{ij} followed a normal distribution among studies. We constructed a linear relationship with sex:

$$\theta_{ij} = \alpha_j + \beta_j Sex_{ij} \quad (20)$$

$$\alpha_j \sim \text{normal}(\mu_\alpha, \sigma_\alpha^2) \quad (21)$$

$$\beta_j \sim \text{normal}(\mu_\beta, \sigma_\beta^2) \quad (22)$$

If we added the study-level covariate into the model above, the formula (21) was modified as:

$$\alpha_j \sim \text{normal}(\mu_\alpha + \sum \beta_p X_{pj}, \sigma_\alpha^2) \quad (23)$$

We obtained the pooled prevalence of VitD inadequacy for male and female respectively:

$$\text{Prevalence (Male)}=exp(\mu_\alpha)/(1+exp(\mu_\alpha)) \quad (24)$$

$$\text{Prevalence (Female)}=exp(\mu_\alpha+\mu_\beta)/(1+exp(\mu_\alpha+\mu_\beta)) \quad (25)$$

And the Odds Ratio:

$$\text{Odds Ratio (Female vs. Male)}=exp(\mu_\beta) \quad (26)$$

The age trend analysis was conducted only for children and adolescents (age⩽18years), and older people(age⩾60 yeas) .Table C display the data structure of the age-specific VitD inadequacy. Each row indicated a study-age group, and the mid-point values of each age group were used as continuous variables to construct a linear trend HB model.

Table C. Data structure of the age-specific VitD inadequacy(children)

Study-age(ij)	Study(j)	Age_{ij}	n_{ij}	r_{ij}
1	1	3	…	…
2	1	4	…	…
3	1	5	…	…
4	2	4	…	…
…	…	…	…	…

The regression model for age was similar as for sex.

In the ij study-age group, r_{ij} followed the binomial distribution:

$$r_{ij}\sim\text{binomial}(n_{ij},p_{ij}) \quad (1)$$

The logit transformation of p_{ij}, which was the θ_{ij} followed a normal distribution among studies, and we constructed a linear relationship with age:

$$\theta_{ij}=\alpha_j+\beta_j Age_{ij} \quad (27)$$

$$\alpha_j\sim\text{normal}(\mu_\alpha,\sigma_\alpha^2) \quad (21)$$

$$\beta_j\sim\text{normal}(\mu_\beta,\sigma_\beta^2) \quad (22)$$

Then we used the estimated prevalence of VitD inadequacy of ages from 1 to 18, or 60 to 90 to draw the age trend plot.

$$\text{Prevalence }(Age_k)=exp(\mu_\alpha+\mu_\beta Age_k)/(1+exp(\mu_\alpha+\mu_\beta Age_k)) \quad (28)$$

Where *k*= 1 to 18 for children and adolescents, and *k*=60 to 90 for older people.
If we added the study-level covariate into the above model, the formula (21) was modified as:

$$\alpha_j \sim \text{normal}(\mu_\alpha + \sum \beta_p X_{pj}, \sigma_\alpha^2) \quad (23)$$

And then we could draw the age trend of VitD inadequacy for each level of the covariate respectively.

For the mean concentration of VitD, the sex or age HB regression models were similar with the regression of prevalence of VitD inadequacy, except for the within study-sex or study-age group distribution:

$$mean_{ij} \sim \text{normal}(\theta_{ij}, {\sigma_{ij}}^2) \quad (4)$$

3. Parameter Estimation

All HB models were fitted with the Markov chain Monte Carlo (MCMC) algorithm and Gibbs sampling to estimate the posterior distribution of the outcomes. Non-informative prior was specified for all the parameters. The uncertainty intervals (or CrI) represent the 2.5-97.5 percentiles of the posterior distribution of the estimation. Inferences were based on 5000 iterations, and the first 2500 of which were used as burn-in. All the hierarchical Bayesian analyses were performed using the "R2jags" package of R software (version 4.0.3). In the BUGS model, normal distribution was written as mean and precision $\tau^2 = \frac{1}{\sigma^2}$ which was not the variance σ^2 .

4. Code of "R2jags" package from R software

The codes from R in our study were displayed below for the analysis of prevalence of vitamin D deficiency, inadequacy, and sufficiency, the codes for the analysis of VitD concentration were omit.

4.1 Prevalence of VitD deficiency/inadequacy/sufficiency without covariates

```
# write bugs model in R as a function
bayesmodel.1<-function(){
   for (i in 1:N){                          # N, the number of studies
      r[i] ~ dbinom (p[i], n[i])            # data model
      logit(p[i])<-y[i]                     # the logit transformation for p
   }
    for (i in 1:N){
      y[i] ~ dnorm (mu, tau)                # hierarchical model for y
   }
    tau <- pow(sigma, -2)                   # tau = 1/sigma^2
    mu ~ dnorm (0.0, 1.0E-6)                # noninformative prior on mu
    sigma ~ dunif (0, 1000)                 # noninformative prior on sigma
    prevalence<-exp(mu)/(1+exp(mu))         # the pooled prevalence
   sigma2<-sigma*sigma
}
jags.params.1 <-c("mu","sigma2","p","prevalence")
set.seed(123)
jags.1 <- jags(data=list(N=length(data$Studyid),r=data$count,n=data$n),
inits=NULL, jags.params.1, n.iter=5000, model.file=bayesmodel.1)
```

#Where *data* was the dataframe of each outcome for children or adults, *studyid* was the study identification for each study, *count* was the number of populations with vitamin D deficiency/ inadequacy, *n* was the corresponding total number of investigated populations.

#The forest plot was draw from the observational prevalence of each study and the pooled prevalence of deficiency/inadequacy from the above model.

4.2 Prevalence of VitD inadequacy with study-level covariates

```
# write bugs model in R as a function
bayesmodel.2<-function(){
   for (i in 1:N){                          # N, the number of studies
      r[i] ~ dbinom (p[i], n[i])            # data model
      logit(p[i])<-y[i]                     # the logit transformation for p
   }
   for (i in 1:N){
```

```
    y[i] <-beta0[i]+beta1*x1[i]+beta2*x2[i]
    beta0[i] ~ dnorm (mu, tau)                  # hierarchical model for y

  }
   tau <- pow(sigma, -2)                        # tau = 1/sigma^2
   sigma ~ dunif (0, 1000)                      # noninformative prior on sigma
   mu~ dnorm (0.0, 1.0E-6)                      # noninformative prior on mu
   beta1~ dnorm (0.0, 1.0E-6)                   # noninformative prior on beta1
   beta2~ dnorm (0.0, 1.0E-6)                   # noninformative prior on beta2

  P.0 <-exp(beta0)/(1+exp(beta0))               # the prevalence if x1==0&x2==0
  P.1 <-exp(beta0+beta1)/(1+exp(beta0+beta1))   # the prevalence if x1==1
  P.2 <-exp(beta0+beta2)/(1+exp(beta0+beta2))   # the prevalence if x2==1
  OR.1 <-exp(beta1)                             # the OR in x1=1 vs. x1==0&x2==0
  OR.2 <-exp(beta2)                             # the OR in x2=1 vs. x1==0&x2==0
  OR.2_1 <-exp(beta2-beta1)                     # the OR in x2=1 vs. x1==1
  sigma2<-sigma*sigma

}
jags.params.2 <-c("mu","beta1","beta2","sigma2","p","P.0","P.1","P.2","OR.1",
"OR.2", "OR.2_1")
set.seed(123)
jags.2<-    jags(data=list(N=length(data$Studyid),r=data$count,n=data$n,
x1=data$x1, x2=data$x2),    inits=NULL, jags.params.2, n.iter=5000,
model.file=bayesmodel.2)
```

#The meta-regression with study-level covariates were applied in vitamin D inadequacy only because of the limited number of studies for vitamin D deficiency. #Where *data* was the dataframe of vitamin D inadequacy for children or adults, *studyid* was the study identification for each study , *count* was the number of population with vitamin D inadequacy, *n* was the total number of investigated population, and x1,x2 were the indicator variables of the study-level covariate.

4.3 Sex-specific prevalence of VitD inadequacy

```
bayesmodel.3 <-function(){
   for (i in 1:N){                          # N, the number of study-sex groups
      r[i] ~ dbinom (p[i], n[i])            # data model
      logit(p[i])<-y[i]                              # the logit transformation for p
      y[i] <- alpha[Study[i]]+beta[Study[i]]*sex[i]     # hierarchical model for y

   }
   for (j in 1:J){                          # J, the number of study
      alpha[j] ~ dnorm(mu.a,tau.a)
        beta[j] ~ dnorm(mu.b,tau.b)
   }
   tau.a <- pow(sigma.a,-2)                  # tau.a = 1/sigma.a^2
   tau.b <- pow(sigma.b,-2)                  # tau.b = 1/sigma.b^2
   sigma.a ~ dunif (0, 1000)                 # noninformative prior on sigma.a
   sigma.b ~ dunif (0, 1000)                 # noninformative prior on sigma.b
   mu.a ~ dnorm (0.0, 1.0E-6)                # noninformative prior on mu.a
   mu.b ~ dnorm (0.0, 1.0E-6)                # noninformative prior on mu.b
   P.male    <-exp(mu.a)/(1+exp(mu.a))              # the prevalence for male
   P.female <-exp(mu.a+mu.b)/(1+exp(mu.a+mu.b))     # the prevalence for female
   OR        <-exp(mu.b)                            # the OR for female vs. male
  sigma.a2<-sigma.a*sigma.a

}
jags.params.3<-c("mu.a","mu.b","sigma.a2","sigma.b","p","P.male","P.female","OR")
set.seed(123)
jags.sex <-jags(data=list(N=length(data$Studyid),J=length(unique(data$Studyid)),
r=data$count,n=data$n,Study=data$Studyid,sex=data$sex), inits=NULL,
jags.params.3, n.iter=5000,model.file=bayesmodel.3)
```

#Where *data* was the dataframe of sex-specific vitamin D inadequacy for children or adults, *studyid* was the study identification for each study , *count* was the sex-specific number of population with vitamin D inadequacy in each study, *n* was the corresponding number of investigated population, and sex=1 indicate female and sex=0 indicate male.

4.4 Age-specific prevalence of VitD inadequacy

```
bayesmodel.4<-function(){
   for (i in 1:N){                                    # N, the number of study-age groups
      r[i] ~ dbinom (p[i], n[i])                      # data model
      logit(p[i])<-y[i]                                  # the logit transformation for p
      y[i] <- alpha[Study[i]]+beta[Study[i]]*age[i]     # hierarchical model for y
   }
   for (j in 1:J){                                    # J, the number of study
      alpha[j] ~ dnorm(mu.a,tau.a)
        beta[j] ~ dnorm(mu.b,tau.b)
   }
   tau.a <- pow(sigma.a,-2)                          # tau.a = 1/sigma.a^2
   tau.b <- pow(sigma.b,-2)                          # tau.b = 1/sigma.b^2
   sigma.a ~ dunif (0, 1000)                         # noninformative prior on sigma.a
   sigma.b ~ dunif (0, 1000)                         # noninformative prior on sigma.b
   mu.a ~ dnorm (0.0, 1.0E-6)                        # noninformative prior on mu.a
   mu.b ~ dnorm (0.0, 1.0E-6)                        # noninformative prior on mu.b
   OR <-exp(mu.b)                                 # the OR every one year increased in age
 sigma.a2<-sigma.a*sigma.a

}
jags.params.4 <-c("mu.a","mu.b","sigma.a2","sigma.b","p","OR")
set.seed(123)
jags.age<-jags(data=list(N=length(data$Studyid),J=length(unique(data$Studyid)),
r=data$count,n=data$n,Study=data$Studyid,age= data $age), inits=NULL,
jags.params.4, n.iter=5000, model.file=bayesmodel.4)
```

#Where *data* was the dataframe of age-specific vitamin D inadequacy for children or adults, *studyid* was the study identification for each study , *count* was the number of population with vitamin D inadequacy in each age group, *n* was the corresponding total number of investigated population, and age was the midpoint of age group from each study.

Supplementary tables

Table S1. Characteristics of the included studies

Study ID	First Author	Year of publication	Season of conduction	Province	South or North	Urban or Rural	Assays	Population Setting	Sampling method	Population	Sample size	Age (Years)
(1)	Yuyan Jiang	2013	Unknown	Guangxi	South	Rural	ELISA	School	cluster random sampling	Children and Adolescents	M: 265; F: 247	6-13
(2)	Runxiao Miao	2016	Summer/Autumn	Hebei	North	Rural	LC-MS/MS	School	stratified random sampling	Children and Adolescents	M: 364; F: 356	6-16
(3)	Pengmei Wu	2017	Both	Guangdong	South	Urban	LC-MS/MS	Community	simple random sampling	Children	M: 687; F: 599	0-6
(4)	Peng Shi	2016	Summer/Autumn	Beijing	North	Urban	ECLIA	School	stratified cluster random sampling	Children and Adolescents	M: 286; F: 278	6-13
(5)	Jing Zhao	2010	Winter/Spring	Beijing	North	Rural	ELISA	School	two-stage cluster random sampling	Children and Adolescents	M: 213; F: 168	7-11
(6)	Jie Li	2016	Summer/Autumn	Beijing	North	Rural	ECLIA	School	two-stage cluster random sampling	Children and Adolescents	M: 293; F: 283	6-13
(7)	Wei Li	2014	Winter/Spring	Sichuan	South	Urban	ECLIA	Kindergarten	stratified cluster random sampling	Children	M: 404; F: 349	3-6
(8)	Xianghui Liu	2016	Unknown	Qianghai	North	Both	ELISA	community	stratified random sampling	Children	Total: 869	0-6
(9)	Yiya Liu	2018	Summer/Autumn	Guizhou	South	Rural	LC-MS/MS	School	stratified random sampling	Children and Adolescents	M: 851; F: 891	6-17

(10)	Jing Zhou	2015	Winter/Spring	Hainan	South	Rural	LC-MS/MS	School	stratified cluster random sampling	Children and Adolescents	M: 275; F: 286	6-15
(11)	Chunxia Cui	2016	Summer/Autumn	Inner Mongolia	North	Rural	RIA	School	stratified cluster random sampling	Children and Adolescents	M: 180; F: 179	6-15
(12)	Yan Li	2017	Summer/Autumn	Guangxi	South	Rural	HPLC	School	stratified cluster random sampling	Children and Adolescents	M: 859; F: 814	6-14
(13)	Jinhong Sun	2015	Both	Hebei	North	Urban	ELISA	School	cluster random sampling	Children and Adolescents	M: 149; F: 118	10-12
(14)	Jingjun Zhao	2016	Summer/Autumn	Shaanxi	North	Rural	HPLC	School	stratified cluster random sampling	Children and Adolescents	M: 564; F: 505	6-17
(15)	Liping Meng	2011	Unknown	Shaanxi	North	Rural	RIA	community	Probability proportional sampling	Children	M: 206; F: 216	0-3
(16)	Xianghui Liu	2016	Summer/Autumn	Qinghai	North	Both	ELISA	community	stratified random sampling	Children	M: 113; F: 117	0-7
(17)	Yuqi Wang	2012	Winter/Spring	Hebei	North	Urban	ELISA	Kindergarten	cluster random sampling	Children	M: 146; F: 155	3-6
(18)	Qian Zhang	2016	Summer/Autumn	National	Both	Rural	LC-MS/MS	School	stratified cluster random sampling	Children and Adolescents	M: 5448; F: 5312	5-19
(19)	Qiqin Feng	2018	Summer/Autumn	Hainan	South	Rural	LC-MS/MS	School	stratified cluster random sampling	Children and Adolescents	M: 309; F: 325	6-15
(20)	Xiaolian Xie	2020	Summer/Autumn	Ningxia	North	Urban	ELISA	School	statified cluster random sampling	Children and Adolescents	M: 768; F: 847	6-18
(21)	Yifu He	2017	Summer/Autumn	Hunan	South	Urban	ECLIA	Kindergarten	stratified cluster random sampling	Children	M: 1494; F: 1378	3-5
(22)	Yanheng Luo	2020	Summer/Autumn	Guangdong	South	Urban	ELISA	School	stratified cluster random sampling	Children and Adolescents	M: 235; F: 174	7-14

(23)	Xuchen Meng	2020	Unknown	Chongqing	South	Urban	ECLIA	School	multi-stage stratified random sampling	Children and Adolescents	M: 97; F: 97	6-17
(24)	Xinyi Wang	2017	Winter/Spring	Liaoning	North	Urban	ECLIA	School	stratified cluster random sampling	Children and Adolescents	M: 82; F: 92	12-16
(25)	Jing Li	2018	Summer/Autumn	Ningxia	North	Urban	ELISA	School	multi-stage stratified random sampling	Children and Adolescents	M: 756; F: 826	6-18
(26)	Haibo Li	2020	Both	National	Both	Both	CLIA	School	multi-stage stratified random sampling	Children and Adolescents	M: 5517; F:5179	6-18
(27)	Yan Liu	2018	Both	National	Both	Both	LC-MS/MS	School	multi-stage stratified cluster random sampling	Children and Adolescents	M: 291; F: 272	7-12
(28)	Xueqin Du	2001	Both	Beijing	North	Both	CPBA	School	stratified cluster random sampling	Girls	F: 229	12-14
(29)	Huaqi Zhang	2014	Winter/Spring	Heilongjiang	North	Urban	HPLC	School	stratified cluster random sampling	Children and Adolescents	M: 832; F: 656	7-11
(30)	Pei Xiao	2020	Both	National	Both	Both	CLIA	School	stratified cluster random sampling	Children and Adolescents	M: 3057; F: 3034	6-18
(31)	Zhaoxie Tang	2020	Summer/Autumn	Guangdong	South	Urban	EIA	School	multi-stage cluster random sampling	Children and Adolescents	M: 1340; F: 1340	7-18
(32)	L. H. Foo	2009	Unknown	Beijing	North	Urban	RIA	School	cluster random sampling	Girls	F: 323	15
(33)	Mark A. Strand	2009	Summer/Autumn	Shanxi	North	Rural	RIA	Community	multi-stage cluster random sampling	Children	M: 95; F: 84	1-2
(34)	Jie Wang	2015	Summer/Autumn	Guizhou, Yunnan, Shanxi	Both	Rural	RIA	Community	probability proportional sampling	Children	M: 711; F: 659	0-3

(35)	Yanhong Li	2018	Summer/Autumn	Yunnan	South	Rural	CLIA	Community	stratified cluster sampling	Children	M: 245; F: 693	0.5-2
(36)	Yichun Hu	2017	Both	National	Both	Both	RIA	Community	multi-stage stratified proportional random cluster sampling	Children and Adolescents	M: 7288; F: 7185	6-17
(37)	Xirui Wang	2020	Winter/Spring	Shanghai	South	Urban	LC-MS/MS	Kindergarten	cluster random sampling	Children	M: 185; F: 166	3-6
(38)	Xiaoyun Shan	2021	Winter/Spring	Hebei, Zhejiang, Guangxi	Both	Both	LC–MS/MS	School	multi-stage cluster random sampling	Children and Adolescents	M:1929; F:1879	6-17
(39)	Xianfeng Zhao	2010	Winter/Spring	Sichuan, Gansu, Shaan xi	Both	Rural	RIA	Community	multi-stage cluster random sampling	Children	M: 110; F: 89	2-5
(40)	Yanhong Li	2019	Summer/Autumn	Yunnan	South	Rural	CLIA	Community	multi-stage stratified cluster random sampling	Children	M: 604; F 575	0.5-2
(41)	Jingjun Zhao	2020	Summer/Autumn	Shaanxi	North	Rural	LC-MS/MS	School	multi-stage stratified cluster random sampling	Children and Adolescents	M: 1507; F: 1456	6-17
(42)	Hong Cheng	2021	Winter/Spring	Beijing	North	Both	CLIA	School	stratified cluster random sampling	Children and Adolescents	M: 5949; F: 6011	6-16
(43)	Xirui Wang	2020	Winter/Spring	Shanghai	South	Urban	LC-MS/MS	Kindergarten	stratified cluster random sampling	Children	M: 185; F: 166	3-6
(44)	Yanjuan Wang	2019	Summer/Autumn	Jiangsu	North^{+}	Urban	LC-MS/MS	Kindergarten and Community	cluster random sampling	Children	M: 61; F: 47	2-6

(45)	Mi Tian	2017	Winter/Spring	Chongqing	South	Rural	LC-MS/MS	Kindergarten	cluster random sampling	Children	M: 155; F: 130	3-6
(46)	Xinmei Lin	2021	Unknown	Sichuan	South	Rural	LC-MS/MS	Community	stratified cluster random sampling	Children	M: 1056; F: 1066	0-6
(47)	Yetao Luo	2020	Unknown	Chongqing	South	Both	HPLC	School	stratified cluster random sampling	Children and Adolescents	M: 93; F: 75	6-12
(48)	Jingrong Chen	2021	Winter/Spring	Chongqing	South	Both	LC-MS/MS	School	stratified cluster random sampling	Children and Adolescents	M: 766; F: 747	6-17
(49)	Bingxiao Liu	2017	Both	National	Both	Rural	RIA	Community	multi-stage stratified random sampling	Women	F: 1520	18-44
(50)	Ying Liu	2010	Winter/Spring	Beijing	North	Urban	RIA	Community	cluster random sampling	Women	F: 400	60-85
(51)	Pianpian Fan	2021	Winter/Spring	Sichuan	South	Both	ELISA	Community	cluster random sampling	Women	F: 1394	29-95
(52)	Xiaomin Fu	2015	Unknown	Beijing	North	Urban	ECLIA	Community	stratified cluster random sampling	Men	M: 2292	40-79
(53)	Qiao Zhang	2011	Winter/Spring	Guizhou	South	Urban	RIA	Community	cluster random sampling	Adults	M: 627; F: 867	20~79
(54)	Shian Yin	2010	Winter/Spring	Sichuan, Gansu, Shaanxi	Both	Rural	RIA	Community	multi-stage stratified random sampling	Women	F: 344	15-44
(55)	Haipeng Hui	2018	Both	Beijing	North	Urban	ECLIA	Community	cluster random sampling	Adults	M: 222; F: 174	20-44
(56)	Yong Wan	2014	Winter/Spring	Sichuan	South	Both	ELISA	Community	cluster random sampling	Women	F: 291	64

(57)	Yi Tang	2016	Winter/Spring	Sichuan	South	Both	ELISA	Community	cluster random sampling	Women	F: 376	30-90
(58)	Lichun Huang	2014	Summer/Autumn	Zhejiang	South	Urban	RIA	Community	multi-stage cluster random sampling	Children and Adolescents, Adults	M: 223; F: 218	≥6
(59)	Shanrong Lai	2017	Winter/Spring	Fujian	South	Both	ELISA	Community	stratified cluster random sampling	Children and Adolescents, Adults	M: 647; F: 538	8-68
(60)	Wenjuan Ma	2017	Both	Gansu	North	Both	CLIA	Community	multi-stage stratified probability population sampling	Adults	M: 4740; F: 6417	18-79
(61)	Jing Liu	2018	Both	Gansu	North	Both	CLIA	Community	multi-stage stratified probability population sampling	Adults	M: 4740; F: 6417	18-79
(62)	Xiaopeng Li	2016	Winter/Spring	Guangxi	South	Both	ELISA	Community	multi-stage stratified random sampling	Adults	M: 308; F: 327	≥18
(63)	Meina Tian	2016	Summer/Autumn	Hebei	North	Both	RIA	Community	multi-stage stratified random sampling	Children and Adolescents, Adults	M: 825; F: 850	≥6
(64)	Zhen Cang	2017	Both	Shanghai, Zhejiang, Jiangsu, Anhui and Jiangxi	South	Both	CLIA	Community	multi-stage stratified random sampling	Adults	M: 5120; F: 7542	55
(65)	Yanling Zhang	2014	Summer/Autumn	Shandong	North	Urban	ELISA	Community	cluster random sampling	Adults	M: 397; F: 847	20-82
(66)	Guozhong Miao	2017	Unknown	Jiangsu	South	Both	ELISA	Community	multi-stage stratified random sampling	Adults	M: 171; F: 197	≥18

(67)	Yanling Zhang	2014	Summer/Autumn	Shandong	North	Both	ELISA	Community	stratified random sampling	Adults	M: 562; F: 1220	40-75
(68)	Yanying Guo	2015	Summer/Autumn	Xinjiang	North	Urban	ECLIA	Community	cluster random sampling	Adults	M: 563; F: 1295	18-84
(69)	Yun Chen	2018	Unknown	Jiangsu	South	Both	ELISA	Community	multi-stage cluster random sampling	Adults	M: 171; F: 197	19-95
(70)	Mingchen Zhang	2015	Summer/Autumn	Xinjiang	North	Both	ECLIA	Community	multi-stage stratified cluster random sampling	Adults	M: 581; F: 364	30-75
(71)	Mingchen Zhang	2014	Summer/Autumn	Xinjiang	North	Both	ECLIA	Community	multi-stage stratified cluster random sampling	Adults	M: 380; F: 548	30-75
(72)	Xiaohui Zhou	2012	Summer/Autumn	Xinjiang	North	Both	ELISA	Community	multi-stage stratified cluster random sampling	Adults	M: 813; F: 916	≥55
(73)	Fangfang Zhu	2014	Winter/Spring	Jiangsu	South	Both	ELISA	Community	multi-stage cluster random sampling	Women	F: 1726	≥30
(74)	Haiyang Zhao	2014	Unknown	Shanghai	South	Urban	LC-MS/MS	Community	simple random sampling	Adults	M: 120; F:128	40-90
(75)	Ling Lu	2009	Winter/Spring	Beijing, Shanghai	Both	Both	RIA	Community	mulit-stage stratified random sampling	Adults	M: 1443; F: 1819	50-75
(76)	Jing Zhao	2011	Unknown	Beijing	North	Urban	ECLIA	Community	mulit-stage stratified random sampling	Women	F: 1724	47-108
(77)	Hankui Lu	2012	Winter/Spring	Shanghai	South	Urban	ECLIA	Community	cluster random sampling	Adults	M: 649; F: 1939	20-89

(78)	Minfang Tao	2013	Winter/Spring	Shanghai	South	Urban	ECLIA	Community	cluster random sampling	Women	F: 1382	20-85
(79)	Hao Peng	2013	Winter/Spring	Jiangsu	South	Both	ELISA	Community	multi-stage cluster random sampling	Women	F: 1726	≥30
(80)	Conghui Guan	2014	Summer/Autumn	Gansu	North	Urban	EIA	Community	multi-stage stratified probability population sampling	Adults	M: 2902; F: 7136	40-75
(81)	Donghu Zhen	2015	Summer/Autumn	Gansu	North	Urban	EIA	Community	multi-stage stratified probability population sampling	Adults	M: 2902; F: 7136	40-75
(82)	Xiaoyu Feng	2016	Unknown	Shandong	North	Urban	ELISA	Community	stratified random sampling	Adults	M: 310; F: 376	60-89
(83)	M. Li	2016	Both	National	Both	Both	CLIA	Community	stratified random sampling	Adults	M: 500; F: 936	≥15
(84)	C. Gao	2017	Both	Shanghai	South	Urban	ECLIA	Community	cluster random sampling	Women	F: 2551	55-69
(85)	Jing Chen	2017	Both	National	Both	Both	RIA	Community	multi-stage stratified probability population sampling	Adults	M: 2948; F: 3066	≥60
(86)	Wei Zhu	2018	Unknown	Shanghai	South	Urban	ELISA	Community	cluster random sampling	Adults	M: 164; F: 344	18-74
(87)	Danting Li	2018	Both	Sichuan	South	Both	HPLC	Community	stratified cluster random sampling	Adults	M: 566; F: 948	25-65
(88)	Fang Fang	2018	Summer/Autumn	Tianjin	North	Both	CLIA	Community	stratified cluster random sampling	Adults	M: 762; F: 1052	≥18

(89)	Zhiwei Xia	2019	Unknown	Beijing	North	Urban	RIA	Community	cluster random sampling	Adults	M: 275; F: 510	≥60
(90)	Zhongjian Xie	2018	Both	National	Both	Both	LC-MS/MS	Community	multi-stage stratified random sampling	Women	F: 1684	65.4
(91)	Y. Yao	2019	Both	Hainan	South	Both	RIA	Community	cluster random sampling	Adults	M: 175; F: 768	≥100
(92)	Tao Huang	2019	Both	National	Both	Both	CLIA	Community	multi-stage stratified random sampling	Adults	M: 6891; F: 6674	30-79
(93)	Xiaoning Yan	2019	Winter/Spring	Shanxi	North	Urban	LC-MS/MS	Community	stratified random sampling	Adults	M: 176; F: 126	46
(94)	Dongdong Zhang	2021	Summer/Autumn	Henan	North	Rural	ELISA	Community	stratified cluster random sampling	Adults	M: 789; F: 925	≥18
(95)	Jia Wei	2019	Summer/Autumn	National	Both	Both	ELISA	Community	multi-stage stratified cluster random sampling	Adults	M: 991; F: 1189	≥65
(96)	Ling Liu	2020	Both	National	Both	Both	ELISA	Community	multi-stage stratified cluster random sampling	Adults	M: 1197; F: 1296	≥65
(97)	Jianhua Jin	2015	Winter/Spring	Zhejiang	South	Both	ECLIA	Community	stratified cluster random sampling	Adults	M: 186; F: 326	40-75
(98)	Xing Li	2019	Summer/Autumn	Henan	North	Rural	ECLIA	Community	cluster random sampling	Adults	M: 743; F: 785	18-79
(99)	Qiushi Wei	2015	Summer/Autumn	Guangzhou	South	Urban	ECLIA	Community	simple random sampling	Adults	M: 122; F: 188	17-88
(100)	Feng Chen	2019	Both	Liaoning	North	Urban	LC-MS/MS	Community	random cluster sampling	Adults	M: 1239; F: 2226	≥60

(101)	Qianxuanzi Chen	2009	Unknown	Beijing	North	Urban	ELISA	Community	random sampling	Women	F: 614	45-81
(102)	Zhongxia Ren	2020	Winter/Spring	National	Both	Urban	LC-MS/MS	Community	multi-stage cluster random sampling	Adults	M: 566; F: 1100	≥18
(103)	Na Mi	2019	Both	Qinghai	North	Both	CLIA	Community	stratified cluster random sampling	Adults	M: 935; F: 938	≥18
(104)	Xiaowei Chen	2017	Winter/Spring	Zhejiang	South	Rural	CLIA	Community	random sampling	Women	F: 486	≥40
(105)	Yichun Hu	2020	Both	National	Both	Both	ELISA	Community	multi-stage stratified probability population sampling	Women	F: 3251	18-49

F: Female, M: Male. North and south were divided based on the Qinling Mountains-Huaihe River line boundary.

ELISA: Enzyme-linked immunosorbent assays; ECLIA: Electrochemiluminescence immunoassay; CLIA: Chemiluminescent assay; RIA: Radioimmunoassay; HPLC: High-performance liquid chromatography; LC-MS/MS: Liquid chromatography coupled with mass spectrometry

[+]: The investigation site in this study was above Qinling Mountains-Huaihe River line boundary in Jiangsu province.

Table S2. Risk of bias assessment of the included studies[a]

Study ID	External Validity				Internal Validity						Summary assessment (score)
	Representation[b]	Sampling	Random selection	Non response bias[c]	Data collection	Case definition	Reliability and validity of study tool	Data collection	Prevalence period	Numerators and denominators	
(1)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(2)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(3)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(4)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(5)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(6)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(7)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(8)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(9)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(10)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(11)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(12)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(13)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)

(14)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(15)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(16)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(17)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(18)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(19)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(20)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(21)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(22)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(23)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(24)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(25)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(26)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(10)
(27)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(28)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(29)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(30)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(10)
(31)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(32)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(33)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(34)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)

(35)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(36)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(10)
(37)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(38)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(39)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(40)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(41)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(42)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(43)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(44)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(45)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(46)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(47)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(48)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(49)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(10)
(50)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(51)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(52)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(53)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(54)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(55)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)

(56)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(57)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(58)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(59)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(60)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(61)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(62)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(63)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(64)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(65)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(66)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(67)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(68)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(69)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(70)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(71)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(72)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(73)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(74)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(75)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(76)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)

(77)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(78)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(79)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(80)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(81)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(82)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(83)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(84)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(85)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(86)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(87)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(88)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(89)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(90)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(91)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(92)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(93)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(94)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(95)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(96)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(97)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)

(98)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(99)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)
(100)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(101)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(102)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(10)
(103)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(104)	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(8)
(105)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Low risk(9)

[a]: The risk of bias of the included studies were evaluated by a tool by Hoy.

[b]: Yes: The study was a national survey. No: The study was province or county level.

[c]: Yes: The response rate for the study was ≥75%,or an analysis was performed that showed no significant difference in relevant demographic characteristics between responders and non-responders;

No: The response rate was <75%, or if any analysis comparing responders and non-responders was done, it showed a significant difference in relevant demographic characteristics between responders and non-responders, or haven't reported the response rate.

Table S3. Parameters from HB meta-regression models for Vitamin D inadequacy (< 50 nmol/L)

Covariates	Children and Adolescents		Adults	
	N	Between-study variance (σ^2)	N	Between-study variance (σ^2)
Sampling frame				
National	5		7	
Province or City	20	1.5(0.9, 2.4)	29	1.9(1.2, 2.9)
County	14		7	
Latitude				
South	16		18	
North	16	1.2(0.7, 1.9)	17	1.7(1.1, 2.7)
Both	7		8	
Urbanization				
Urban	14		16	
Rural	17	1.6(1.0, 2.5)	4	1.8(1.1, 2.8)
Both	8		23	
Season				
Summer	18		11	
Winter	11	1.5(0.9, 2.6)	13	1.4(0.8, 2.3)
Both	5		12	
Unknown*	5		7	
Assays				
LC-MS/MS or HPLC	16		4	
ELISA	7		14	
ECLIA	4		10	
CLIA	4	1.5(0.9, 2.4)	5	2.0(1.3, 3.3)
RIA	7		9	
EIA*	1		1	
CPBA*	0		0	
Sex				
Study-sex group	53	1.9(1.0 to 3.4)	59	1.5(0.9, 2.5)
Age (years)				
Study-age group+	89	0.9(0.4, 1.8)	18	2.2(0.7, 7.1)

N: Number of studies for each levels of the covariates. For sex or age, N is the number of study-sex or study-age groups.

*: Categories with less than 3 studies and the "Unknown" category of season were not included in the HB meta-regression model.

+: For adults, populations with age > 60 years old groups were included in the age trend model.

Table S4. Parameters from HB meta-regression models for Vitamin D concentration (nmol/L)

Covariates	Children and Adolescents		Adults	
	N	Between-study variance (σ^2)	N	Between-study variance (σ^2)
Sampling frame				
National	4		4	
Province or City	17	275.4(169.9, 451.7)	24	185.2(108.4, 305.3)
County	15		6	
Latitude				
South	16		13	
North	14	280.4(170.8, 454.7)	16	181.1(108.1, 304.9)
Both	6		5	
Urbanization				
Urban	10		15	
Rural	18	242.9(147.1, 398.8)	1*	180.8(106.7, 301.8)
Both	8		18	
Season				
Summer	15		9	
Winter	11	230.1(130.7, 394.3)	9	153.1(80.6, 280.5)
Both	5		8	
Unknown*	5		8	
Assays				
LC-MS/MS or HPLC	19		3	
ELISA	4		13	
ECLIA	5		5	
CLIA	3	225.3(131.0, 386.6)	6	196.0(112.5, 336.3)
RIA	4		6	
EIA*	0		1	
CPBA*	1		0	
Sex				
Study-sex group	57	325.1(181.7, 571.1)	47	178.0(102.3, 309.4)
Age (years)				
Study-age group+	81	236.2(117.8, 444.5)	19	351.3(117.7, 940.9)

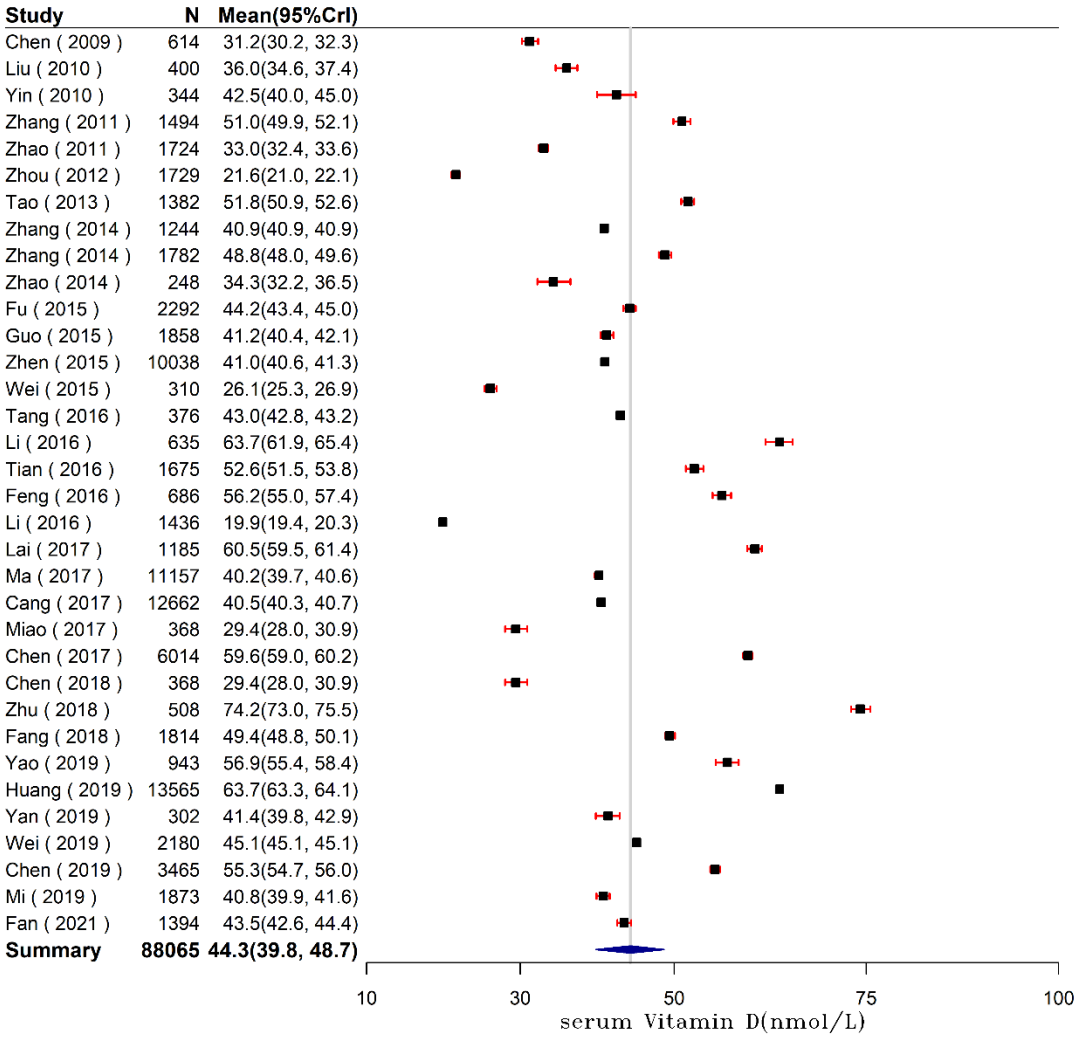
N: Number of studies for each levels of the covariates. For sex or age, N is the number of study-sex or study-age groups.

*: Categories with less than 3 studies and the "Unknown" category of season were not included in the HB meta-regression analysis.

+: For adults, populations with age ≥ 60 years old groups were included in the age trend model.

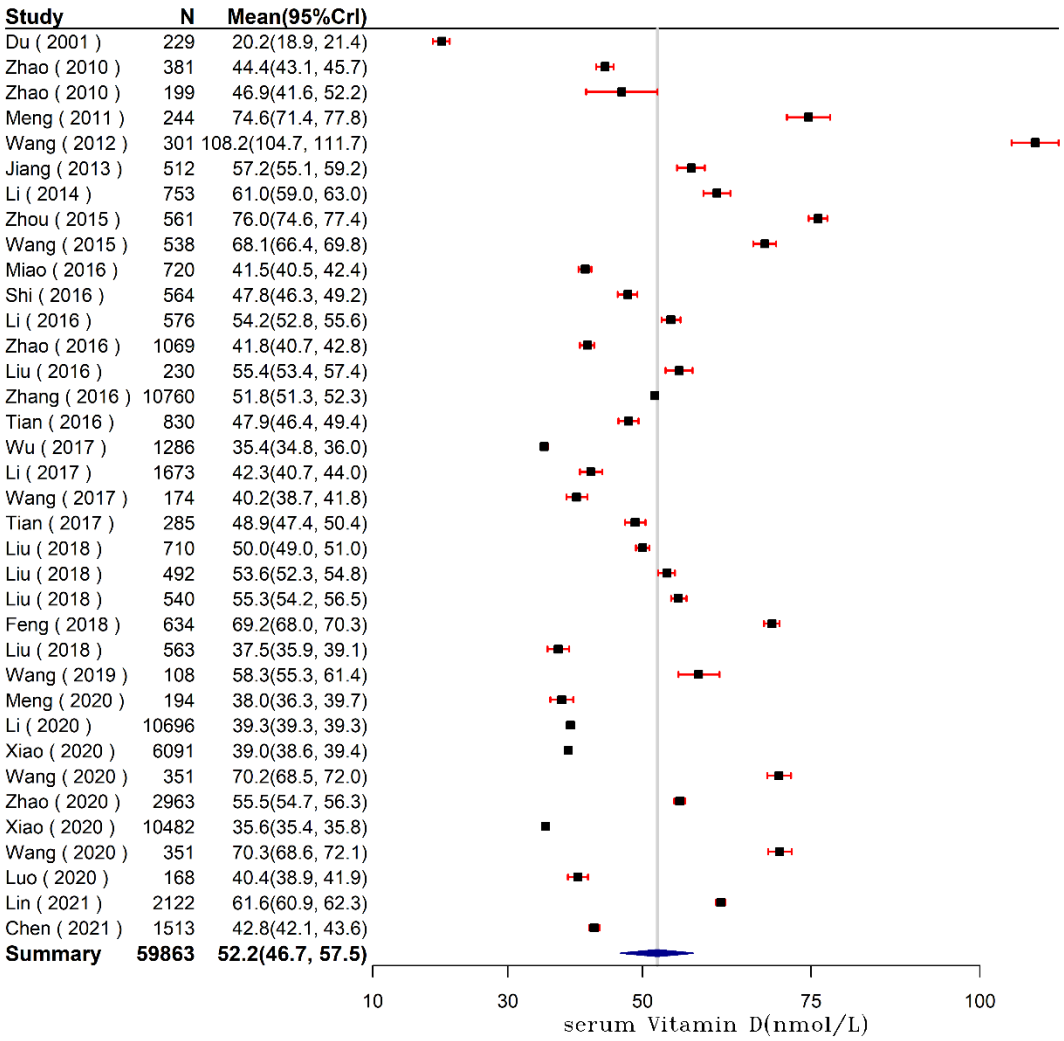
Supplementary figures

Figure S1. Forest plot for overall mean 25(OH)D concentrations of adults in Mainland of China



The forest plot was drawn from the observational mean concentration with 95%CI of each study and the pooled mean concentration with 95%CrI estimated from Hierarchical Bayesian model. N is the total number of participants in the study. Thirty-five individual studies were included in this model. The between-study variance (σ^2) estimated from the model was 175.3(104.6, 288.9).

Figure S2. Forest plot for overall mean 25(OH)D concentrations of children and adolescents in Mainland of China



N is the total number of participants in the study. The forest plot was drawn from the observational mean concentration with 95%CI of each study and the pooled mean concentration with 95%CrI estimated from Hierarchical Bayesian models. Thirty-five individual studies were included in this model. The between-study variance (σ^2) estimated from the model was 273.2(167.9, 449.3).

Figure S3. Pooled prevalence of Vitamin D inadequacy (A) and overall mean 25(OH)D concentrations (B) of adults in Mainland of China based on sex

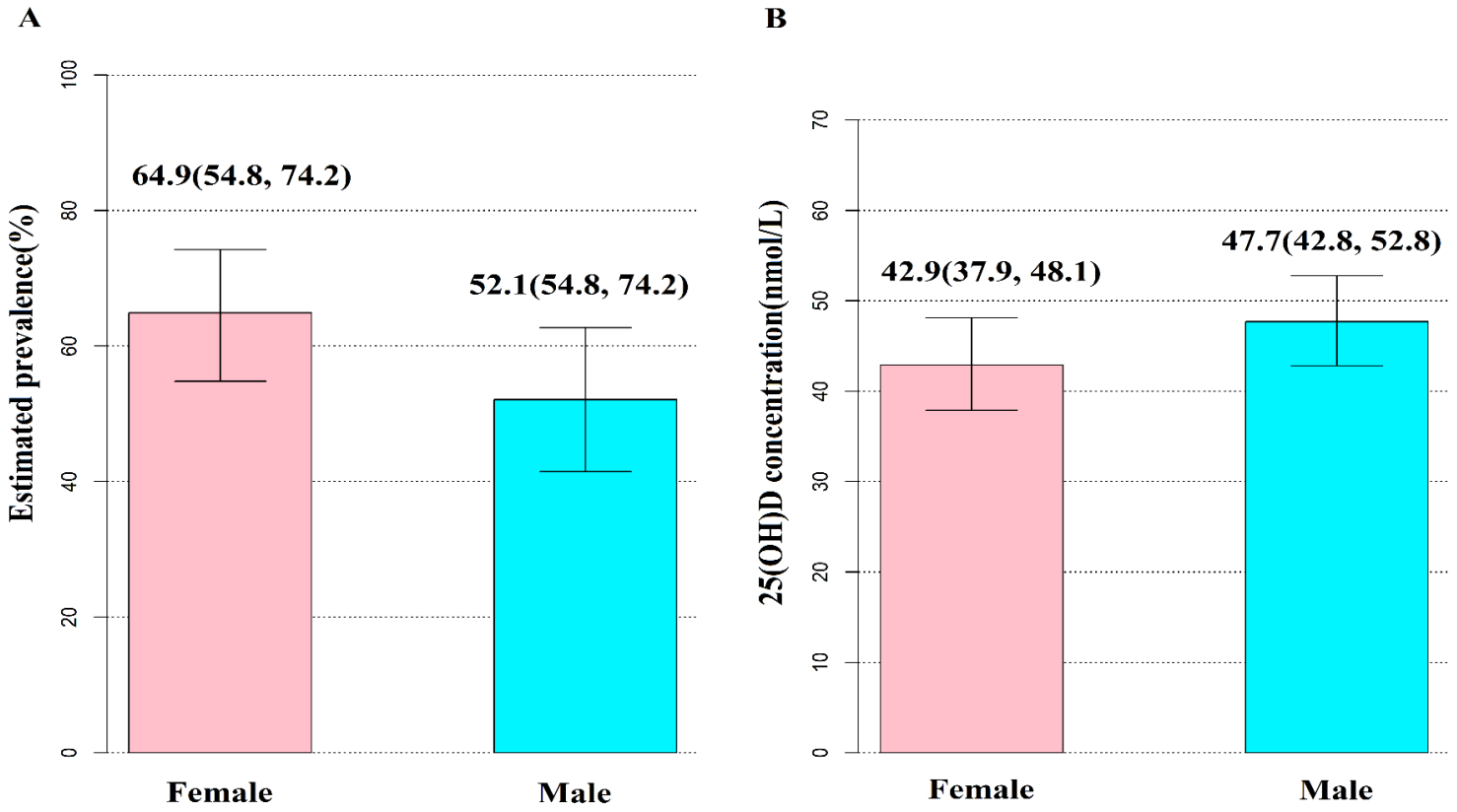
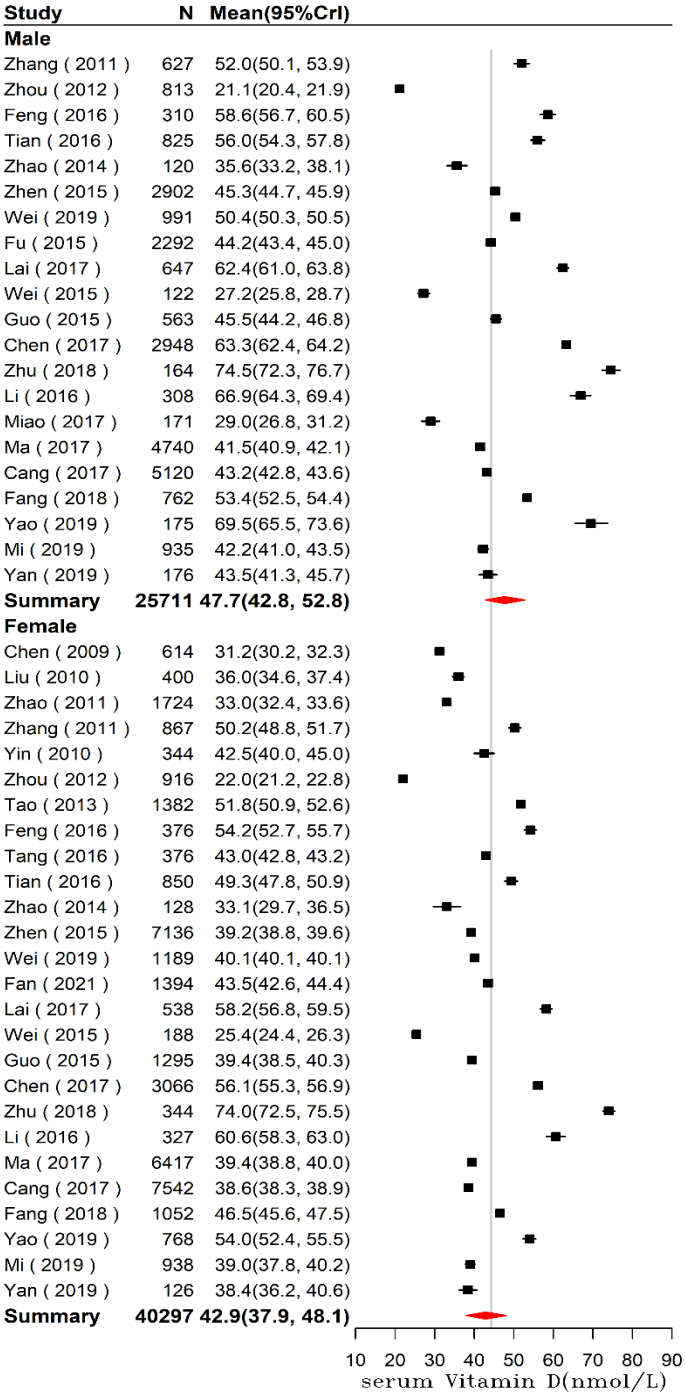
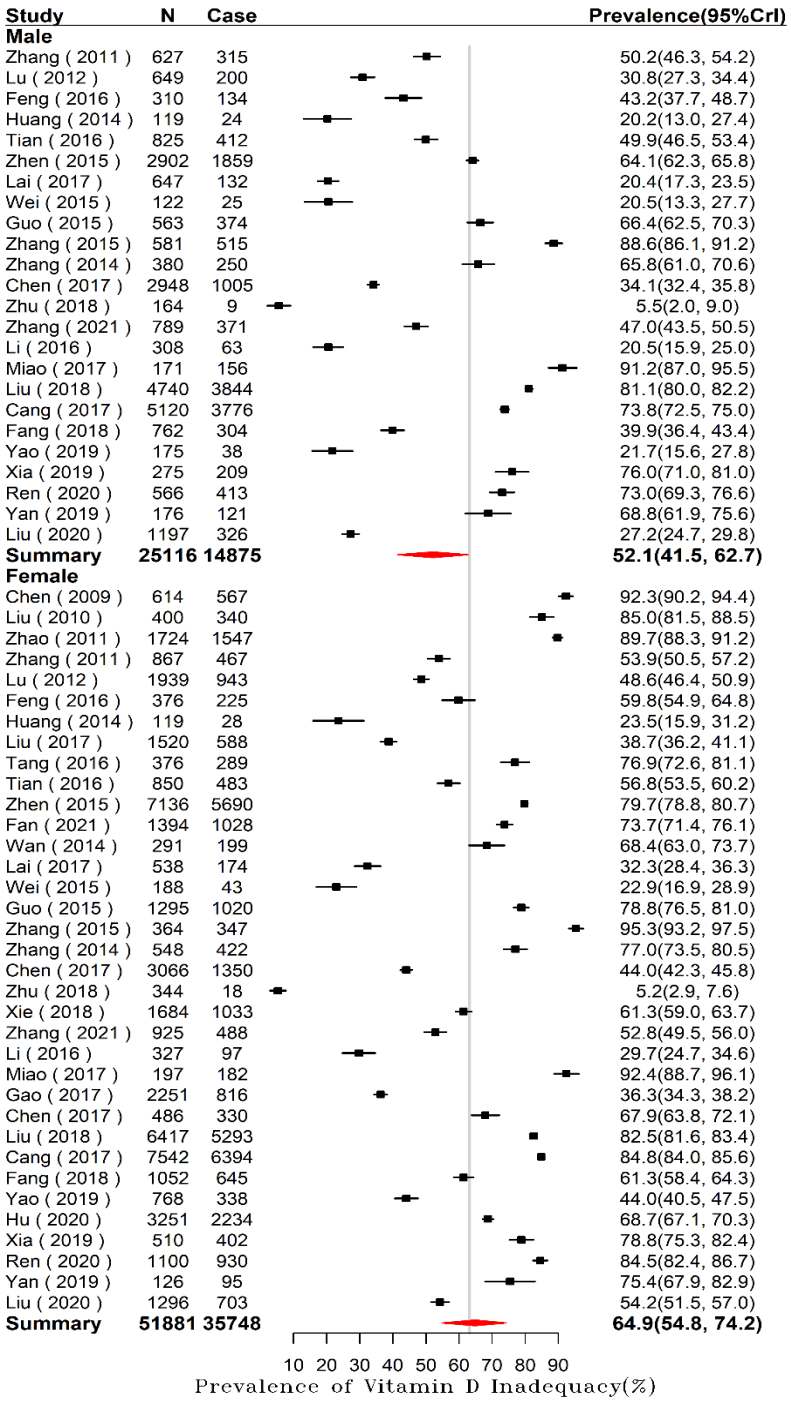


Figure S4. Forest plot for mean 25(OH)D concentrations of adults in Mainland of China based on sex



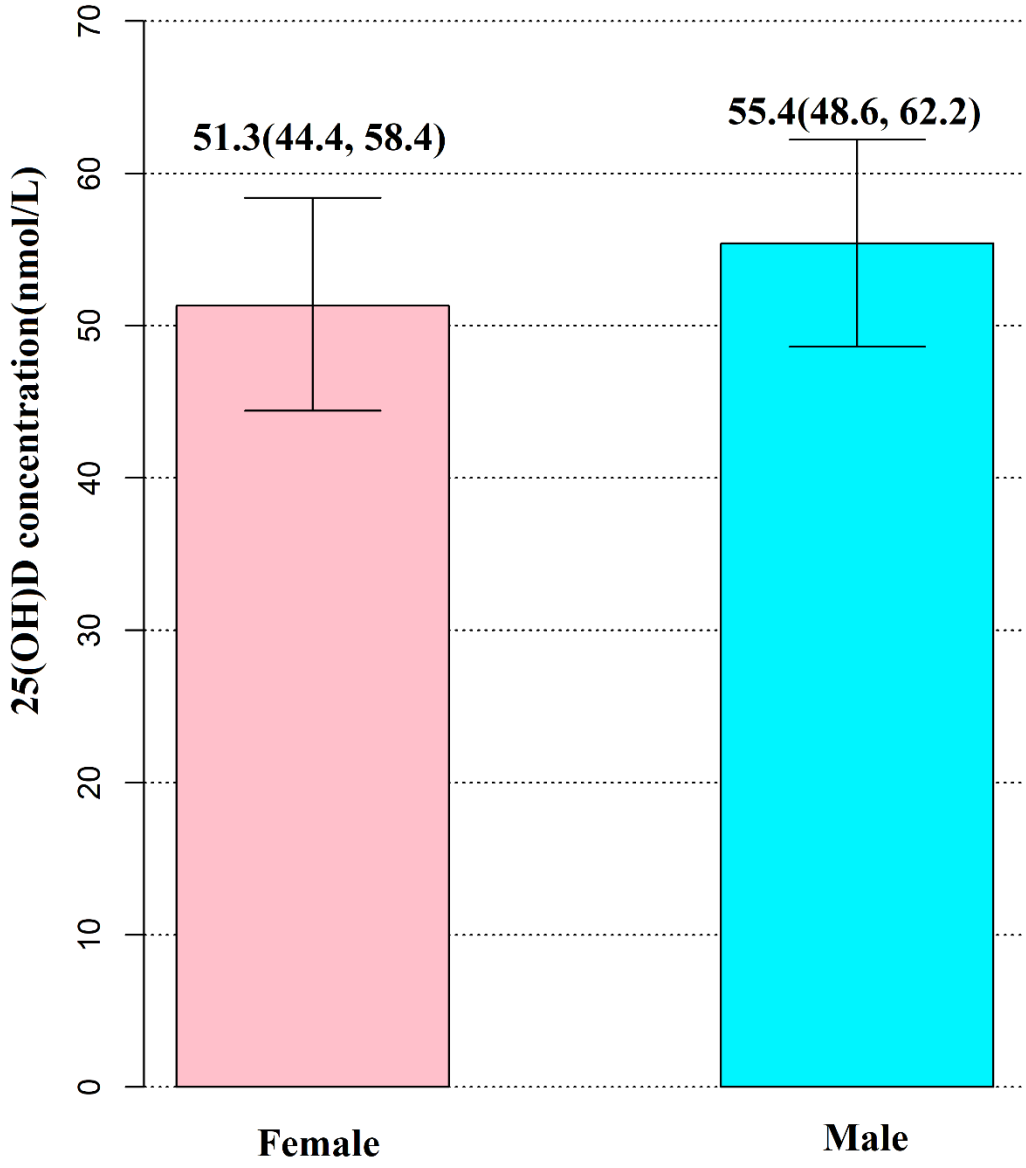
The forest plot was drawn from the observational mean concentration with 95%CI of each study. The pooled mean concentration with 95%CrI was estimated from Hierarchical Bayesian models.

Figure S5. Forest plot for Vitamin D inadequacy of adults in Mainland of China based on sex



The forest plot was drawn based on the observational prevalence with 95%CI of each study. The pooled prevalence with 95%CrI was estimated using Hierarchical Bayesian models.

Figure S6. Estimated mean 25(OH)D concentrations of children and adolescents in Mainland of China based on sex



References

1. Jiang YY, Tan ZZ, Su B. Relation between vitamin D status and growth in school children. Applied Prev Med. 2013(3):135-7,41.
2. Miao RX, Zhu XB, Song LJ, Liu CQ, Tian MN, Chen L. Analysis of serum vitamin D levels of primary and middle school students in poverty-stricken areas of Hebei in 2014.Practical Preventive Medicine. 2016(11).
3. Wu PM, Ying J, Zhang RZ, Sui FX. Status of vitamin D nutrition and its relationship with height development in children aged 0-6 years in Longhua New District of Shenzhen City,2016. Practical Preventive Medicine. 2017;24(12):1446-9.
4. Shi P, Wang Z, Ba L. Nutritional status of vitamin D among primary and middle school students in Chaoyang District of Beijing. Occupation and Health. 2016(19).
5. Zhao J. Body vitamin D content and its relationship with body composition of children in Huairou district of Beijing. Chinese Journal of Epidemiology. 2010(1).
6. Zhang J, Gao YJ, Zhao Y, Yu YJ, Zheng DS, Teng KQ. Analysis on vitamin D nutrition status among 576 middle and primary school students in Miyun District of Beijing. Occupation and Health. 2016(14).
7. Li W, Cao L,Zhang YG,Luo HQ,Wu KM. Analysis of 25-hydroxy vitamin D levels of 3-6 years old children in Chengdu. Chinese Journal of Child Health Care. 2014(05).
8. Liu XH, Wang SL, Tian X, et al. Investigation and analysis on the level of 25-hydroxyvitamin D in children aged (0～6) in high altitude area. Journal of High Altitude Medicine. 2016(04).
9. Liu YY, He LJ, Zhang XQ, et al. Analysisi of vitamin D nutritional status of students in Guizhou Province after implementing "Nutrition Improvoment Program for Compulsory Students in Rural Areas". Chin J Sch Health, 2018, 39(8):1150-1155
10. Zhou J, Yin CF, Feng QQ, Zhang F, Yi C. Serum vitamin D levels among primary and middle school students in Qiongzhong County,Hainan Province. Chin J Sch Health. 2015(09).
11. Cui CX, Xu JH, Song ZZ, Wang HL. Evaluation on the effect of improving nutrition for poor rural students in Zhalaite Banner, Inner Mongolia. Chin J Sch Health. 2016(01).
12. Li Y, Tang ZZ,Yuan ZX,et al. Comparison of nutritional status between boarders and non-boarders of primary school in impoverished areas. Guangxi Medical Journal. 2017(09).
13. Sun JH, Bai T, Dong Y. Monitoring of Vitamin D Nutritional Status of Prepubertal Children and Supplements Countermeasures. International Journal of Laboratory Medicine. 2015(04).
14. Zhao JJ, Chang F, Wang LJ, Xu ZK, Wang X. The current status of vitamin A and vitamin D levels of rural students in Shaanxi. Chin J Sch Health. 2016(12).
15. Meng LP, Fu P, Zhang J, Chang F,Wang LJ,et al. Survey on nutrition and health status in infants under 36 months in Zhen'an, Shaanxi. Chinese Journal of Child Health Care. 2011;19(11).
16. Liu XH, Yan X, Tian X , et al. Analysis of serum 25-dihydroxy vitamin D levels of children in high altitude area in summer. Chinese Journal of Child Health Care. 2016(10).
17. Wang YQ, Wang YS, Jin YR, Wang F, Huang CM, Chen L. Relationship between body mass index and vitamin D level in preschool children. Chinese Journal of Women and Child Health Research. 2012;23(6):709-10,843.
18. Chen Q, Gan Q, Chen J, Pan H , et al. Vitamin D deficiency among students from the National

Nutrition Improvement Program for Rural Compulsory Students in 2013. Chin J Sch Health. 2016(05).
19. Feng QQ, Zhang YH, Zhou J,et al. Analysis on vitamin D nutritional status of rural compulsory students in Hainan,2015.
20. Xie XL, Xie LX, Li J, Ma L, et al. Vitamin D nutritional status and related factors in primary and secondary school students in Yinchuan. Chin J Sch Health. 2020;41(8):1134-7,42.
21. He YF, Cai M, Huang X. Prevalence of vitamin D insufficiency/dediciency among overweight and obese preschool children in Yuelu Distric of Changsha. Journal of Central South University (Medical Sciences). 2017(05).
22. Luo YH, Guo CK,Liang MN. Vitamin D Nutritional Status of Primary and Middle School Students in Duanzhou District, Zhaoqing City. South China J Prev Med. 2020;46(4).
23. Meng XC, Lin XJ, Li HB,et al. A survey on anemia and related indicators of primary and middle school students in a district of Chongqing.Health Med Res&Prac. 2020, 17(2)
24. Wang X, Liu L, Li P, Ma J, Jiang R, Wang R, et al. Reference and Influential Factors of Serum Bone Markers in Chinese Adolescents. Scientific reports. 2017;7(1):17340.
25. Li J, Ding W, Cao J, Sun L, Liu S, Zhang J, et al. Serum 25-hydroxyvitamin D and bone mineral density among children and adolescents in a Northwest Chinese city. Bone. 2018;116:28-34.
26. Li H, Huang T, Xiao P, Zhao X, Liu J, Cheng H, et al. Widespread vitamin D deficiency and its sex-specific association with adiposity in Chinese children and adolescents. Nutrition (Burbank, Los Angeles County, Calif). 2020;71:110646.
27. Liu Y, Li X, Zhao A, Zheng W, Guo M, Xue Y, et al. High Prevalence of Insufficient Vitamin D Intake and Serum 25-Hydroxyvitamin D in Chinese School-Age Children: A Cross-Sectional Study. Nutrients. 2018;10(7).
28. Du X, Greenfield H, Fraser DR, Ge K, Trube A, Wang Y. Vitamin D deficiency and associated factors in adolescent girls in Beijing. The American journal of clinical nutrition. 2001;74(4):494-500.
29. Zhang HQ, Teng JH, Li Y, Li XX, He YH, He X, et al. Vitamin D status and its association with adiposity and oxidative stress in schoolchildren. Nutrition (Burbank, Los Angeles County, Calif). 2014;30(9):1040-4.
30. Xiao P, Dong H, Li H, Yan Y, Cheng H, Liu J, et al. Adequate 25-hydroxyvitamin D levels are inversely associated with various cardiometabolic risk factors in Chinese children, especially obese children. BMJ open diabetes research & care. 2020;8(1).
31. Tang Z, Huang S, Ma R, Zheng H, Zhu Y. Low vitamin D status is associated with obesity but no other cardiovascular risk factors in Chinese children and adolescents. Nutrition, metabolism, and cardiovascular diseases : NMCD. 2020;30(9):1573-81.
32. Foo LH, Zhang Q, Zhu K, Ma G, Trube A, Greenfield H, et al. Relationship between vitamin D status, body composition and physical exercise of adolescent girls in Beijing. Osteoporosis international : a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA. 2009;20(3):417-25.
33. Strand MA, Perry J, Zhao J, Fischer PR, Yang J, Li S. Severe vitamin D-deficiency and the health of North China children. Maternal and child health journal. 2009;13(1):144-50.
34. Wang J, Wang H, Chang S, Zhao L, Fu P, Yu W, et al. The Influence of Malnutrition and Micronutrient Status on Anemic Risk in Children under 3 Years Old in Poor Areas in China. PloS one. 2015;10(10):e0140840.
35. Li Y, Li Y, Zhang X, Zhao L, Chen L, Sun H. Vitamin D Status among Young Children Aged 6 to 23 Months from 4 Different Ethnic Groups in Yunnan, China. Food and nutrition bulletin.

2018;39(2):260-5.
36. Hu Y, Chen J, Wang R, Li M, Yun C, Li W, et al. Vitamin D Nutritional Status and its Related Factors for Chinese Children and Adolescents in 2010-2012. Nutrients. 2017;9(9).
37. Wang X, Jiao X, Xu M, Wang B, Li J, Yang F, et al. Effects of circulating vitamin D concentrations on emotion, behavior and attention: A cross-sectional study in preschool children with follow-up behavior experiments in juvenile mice. Journal of affective disorders. 2020;275:290-8.
38. Shan X, Liu C, Luo X, Zou Y, Huang L, Zhou W, et al. Iodine Nutritional Status and Related Factors among Chinese School-Age Children in Three Different Areas: A Cross-Sectional Study. Nutrients. 2021;13(5).
39. Zhao XF, Yin SA, Zhao LY, Fu P, Zhang J, Ma GS. The nutritional status among children under 60 months year-old after one year of the Earthquake in Wenchuan. Chinese journal of preventive medicine. 2010;44(8):691-5.
40. Li YH, Zhang X, Li Y, Zhao MR, Zhao L, Li LX. Vitamin D levels and influencing factors of infants and young children aged 6-23 months in 4 poverty-stricken areas of Yunnan Province. Chin J Dis Control Prev. 2019;23(10).
41. Zhao JJ, Zhao L, Gao Y, Xue B, Chen P,e t al. Nutritional status of vitamin D in primary and middle school students in rural areas of Shaanxi province,2015-2017. Practical Preventive Medicine. 2020;27(9).
42. Cheng H, Xiao P, Hou DQ, Yu ZC, Zhu ZX, Wang HJ, et al. Study on the association between vitamin D and body fat distribution in children and adolescents. Chin J Epidemiol. 2021;42(03):469-74.
43. Wang XR, Yu XD, Zhang LS, Xu L, Yuan YC. Serum 25-hydroxy vitamin D status and the influencing factors in 351 health preschool children. Chinese Journal of Child Health Care. 2020;28(10).
44. Wang YJ, Yu SS, Wang WR, Lu Y, Xiao GY, et al. Study on the levels of vitamin A,D and its influential factors in children between 2 to 6 years old. Chinese Journal of Women and Children Health. 2019;10(3).
45. Tian M. Investigation and analysis of 25-hydroxyvitamin D levels in 285 left-behind children aged 3 to 6 in Yongchuan District, Chongqing. Chongqing Medical University[Master Thesis]; 2017.
46. Lin XM, Huang P, Wang QS, Wang Q, Yuan YX, et al. Survey of vitamin D levels and hemoglobin among children in plateau area, Sichuan. China Tropical Medicine. 2021;21(02):121-3+47.
47. Luo YT, Qu P, Chen M, et al. Relationship between serum 25（OH）D3 and cardiovascular risk factors in children. Chinese Journal of Practical Pediatrics. 2020;35(11).
48. Chen JR, Zhao YN, Zhang J, Tian Y, et al. Vitamin D status of children and adolescents aged 6-17 and its influence factors in some districts and counties, Chongqing. Modern Preventive Medicine. 2021;48(01):50-4.
49. Liu XB, Zhang Y, Mao DQ, Lu JX, Chen J,Yang LC, et al. Serum vitamin D levels of Chinese rural women of childbearing age in 2010-2012. Journal of Health Research. 2017(03).
50. Liu Y, Hu XQ, Fu P, Wang CX, Duan YF, Li J, et al. The association between vitamin D and bone mineral density of urban postmenopausal women in Beijing. Chinese journal of preventive medicine. 2010;44(1):44-7.
51. Fan P, Wang Q, Li J, Lu C, Xu Y, Cao H, et al. Poor Status of Vitamin D: A Survey of Area With Lowest Sunlight Radiation in Sichuan, China. Frontiers in endocrinology. 2021; 12:626983.
52. Fu XM, Li N, Lin M, Zhang W,et al. Correlation analysis of serum calcium levels and risks of

diabetes mellitus in middle-aged and elderly men. Journal of Southern Medical University. 2015(10).
53. Zhang Q, Peng NC, Xu SJ, Zhang S, et al. Vitamin D status in healthy adults in Guiyang of China. Chin J Endocrinol Metab. 2011;27(8).
54. Yin SA, Zhao XF, Zhao LY, Fu P, Zhang J, Ma GS. The nutritional status of reproductive women at one year after the disaster of Earthquake in Wenchuan. Chinese journal of preventive medicine. 2010;44(8):686-90.
55. Hui HP, Han XM, Wang HJ, Yin DW, Liu Y, Cai LL. Serum vitamin D deficiency status and effects of vitamin D3 supplementation on blood glucose and lipids in young and middle-aged residents in Beijing. Chin J Health Care Med. 2018;20(2):121-4.
56. Wan Y, Lang HM, Ai ZH, et al. Bone mineral density and serum-25-hydroxyvitamin D level of 291 postmenopausal women in Chengdu. Chin J Osteoporos Bone Miner Res. 2014(01).
57. Tang Y, Yang J, Cao HY, Chen DC, Yang F. Investigation and analysis of vitamin D, bone metabolic markers, and bone mineral density in females of different age in Chengdu. Chin J Osteoporos. 2016(06).
58. Huang LC, Zhang RH, Zhou B, Jiang FX, et al. An investigation on vitamin D status of residents in Zhejiang province. Zhejiang Pre Med. 2014(09).
59. Lai SR, Huang Z, Su L, Yang LJ, Wu HD. Analysis on vitamin D status and its influeneing factors in populations under different sun exposures in Fujian province. Acta Nutrimenta Sinica. 2017(01).
60. Ma WJ, Liu J, Wei LH, Yang Y, Yang RW,et al. Vitamin D status and its associated risk factors among healthy adults in Gansu province. Chinese Journal of Cinical Nutrition. 2017;25(4).
61. Liu J, Ma W, Wei L, Yang Y, Yang R, Shao F, et al. Adult serum 25(OH)D3 in Gansu province, northwest China: a cross-sectional study. Asia Pacific journal of clinical nutrition. 2018;27(4):832-9.
62. Li XP, Tang ZZ, Zhou WW, et al. Analysis on vitamin D level of adults in five cities /counties of Guangxi. Guangxi Medical Journal. 2016(10).
63. Tian MN, Chen L, Song LJ, et al. Analysis of Vitamin D Nutritional Status of Urban and Rural Residents in Hebei Province. Hebei Medical Journal. 2016(04).
64. Cang Z, Wang NJ, Li Q, Xia FZ,et al. Serum vitamin D levels of the natural population in eastern China. Chinese Journal of Hypertension. 2018;26(5).
65. Zhang YL, Zhang X, Zhang WW, et al. Relationship between serum level of 25-hydroxyvitamin D and fasting blood glucose in healthy adults of Jinan. Journal of Shandong University(Health Sciences). 2014(03).
66. Miao GZ, Zhou M, Liu P, Zhang J. Survey of serum 25-hydroxyvitamin D level in adults in Jiangyin City. Jiangsu J Prev Med. 2017(03).
67. Zhang YL, Ma SH, Zhang X, Yu CX, Zhao JJ. Vitamin D status in middle-aged population and the relationship with hypertension. Shandong Medical Journal. 2014(14).
68. Guo YY, Nurongguli M, Ma FH, Wang XL, Jin XP, et al. Investigation and analysis of vitamin D nutritional status in healthy adults in Urumqi. Labeled Immunoassays&Clin Med. 2015(10).
69. Cheng Y, Liu P, Zhou WJ. Study on the level of vitamin D in adults in Wuxi city and its correlation with blood pressure. South China J Prev Med. 2018;44(4).
70. Zhang MC, Xu XJ, Liu HM, Lei H, Li HX, Mao JF. Vitamin D status and its relationship with blood pressure in Xinjiang Uyghur adults. Chinese Journal of Hypertension. 2015(07).
71. Zhang MC, Li HX, Liu HM, Lei H, Han L, Gao M, et al. Serum vitamin D is low and inversely associated with LDL cholesterol in the Kazak ethnic population: a cross-sectional study. Medical

science monitor : international medical journal of experimental and clinical research. 2014;20:1274-83.
72. Zhou XH, Wang QJ, Zhu MS, Zou T, et at. Epidemiological study of vitamin D level in elderly Uyhur and Han in Xinjiang. Chin J Osteoporos. 2012(05).
73. Zhu FF, Peng H , Zhang Q, et al. Association of vitamin D deficiency with serum uric acid among middle-aged and elderly women of Han nationality. Chinese Preventive Medicine. 2014(04).
74. Zhao HY, Zhu JM, Zhang YW. Investigation of the correlation between vitamin D and bone mineral density in middle-aged and elder people in Shanghai. Chin J Osteoporos. 2014(03).
75. Lu L, Yu Z, Pan A, Hu FB, Franco OH, Li H, et al. Plasma 25-hydroxyvitamin D concentration and metabolic syndrome among middle-aged and elderly Chinese individuals. Diabetes care. 2009;32(7):1278-83.
76. Zhao J, Xia W, Nie M, Zheng X, Wang Q, Wang X, et al. The levels of bone turnover markers in Chinese postmenopausal women: Peking Vertebral Fracture study. Menopause (New York, NY). 2011;18(11):1237-43.
77. Lu HK, Zhang Z, Ke YH, He JW, Fu WZ, Zhang CQ, et al. High prevalence of vitamin D insufficiency in China: relationship with the levels of parathyroid hormone and markers of bone turnover. PloS one. 2012;7(11):e47264.
78. Tao MF, Zhang Z, Ke YH, He JW, Fu WZ, Zhang CQ, et al. Association of serum 25-hydroxyvitamin D with insulin resistance and β-cell function in a healthy Chinese female population. Acta pharmacologica Sinica. 2013;34(8):1070-4.
79. Peng H, Li H, Li C, Chao X, Zhang Q, Zhang Y. Association between vitamin D insufficiency and elevated serum uric acid among middle-aged and elderly Chinese Han women. PloS one. 2013;8(4):e61159.
80. Guan C, Zhen D, Tang X, Yang X, Zhu T, Fu S, et al. The status of 25-hydroxyvitamin D across the spectrum of glucose tolerance among middle-aged and elderly Chinese individuals. Clinical endocrinology. 2014;81(6):834-40.
81. Zhen D, Liu L, Guan C, Zhao N, Tang X. High prevalence of vitamin D deficiency among middle-aged and elderly individuals in northwestern China: its relationship to osteoporosis and lifestyle factors. Bone. 2015;71:1-6.
82. Feng X, Guo T, Wang Y, Kang D, Che X, Zhang H, et al. The vitamin D status and its effects on life quality among the elderly in Jinan, China. Archives of gerontology and geriatrics. 2016;62:26-9.
83. Li M, Lv F, Zhang Z, Deng W, Li Y, Deng Z, et al. Establishment of a normal reference value of parathyroid hormone in a large healthy Chinese population and evaluation of its relation to bone turnover and bone mineral density. Osteoporosis international : a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA. 2016;27(5):1907-16.
84. Gao C, Qiao J, Li SS, Yu WJ, He JW, Fu WZ, et al. The levels of bone turnover markers 25(OH)D and PTH and their relationship with bone mineral density in postmenopausal women in a suburban district in China. Osteoporosis international : a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA. 2017;28(1):211-8.
85. Chen J, Yun C, He Y, Piao J, Yang L, Yang X. Vitamin D status among the elderly Chinese population: a cross-sectional analysis of the 2010-2013 China national nutrition and health survey (CNNHS). Nutrition journal. 2017;16(1):3.
86. Zhu W, Heil DP. Associations of vitamin D status with markers of metabolic health: A

community-based study in Shanghai, China. Diabetes & metabolic syndrome. 2018;12(5):727-32.
87. Li D, Wei H, Xue H, Zhang J, Chen M, Gong Y, et al. Higher serum 25(OH)D level is associated with decreased risk of impairment of glucose homeostasis: data from Southwest China. BMC endocrine disorders. 2018;18(1):25.
88. Fang F, Wei H, Wang K, Tan L, Zhang W, Ding L, et al. High prevalence of vitamin D deficiency and influencing factors among urban and rural residents in Tianjin, China. Archives of osteoporosis. 2018;13(1):64.
89. Xia Z, Man Q, Li L, Song P, Jia S, Song S, et al. Vitamin D receptor gene polymorphisms modify the association of serum 25-hydroxyvitamin D levels with handgrip strength in the elderly in Northern China. Nutrition (Burbank, Los Angeles County, Calif). 2019;57:202-7.
90. Xie Z, Xia W, Zhang Z, Wu W, Lu C, Tao S, et al. Prevalence of Vitamin D Inadequacy Among Chinese Postmenopausal Women: A Nationwide, Multicenter, Cross-Sectional Study. Frontiers in endocrinology. 2018;9:782.
91. Yao Y, Fu S, Li N, Hu F, Zhang H, Zhu Q, et al. Sex, Residence and Fish Intake Predict Vitamin D Status in Chinese Centenarians. The journal of nutrition, health & aging. 2019;23(2):165-71.
92. Huang T, Afzal S, Yu C, Guo Y, Bian Z, Yang L, et al. Vitamin D and cause-specific vascular disease and mortality: a Mendelian randomisation study involving 99,012 Chinese and 106,911 European adults. BMC medicine. 2019;17(1):160.
93. Yan X, Zhang N, Cheng S, Wang Z, Qin Y. Gender Differences in Vitamin D Status in China. Medical science monitor : international medical journal of experimental and clinical research. 2019;25:7094-9.
94. Zhang D, Cheng C, Wang Y, Xue Y, Liu Y, Li W, et al. Serum 25-Hydroxyvitamin D Concentrations and Cardiometabolic Biomarkers in Chinese Rural Population. Hormone and metabolic research. 2021;53(2):105-11.
95. Wei J, Zhu A, Ji JS. A Comparison Study of Vitamin D Deficiency among Older Adults in China and the United States. Scientific reports. 2019;9(1):19713.
96. Liu L, Cao Z, Lu F, Liu Y, Lv Y, Qu Y, et al. Vitamin D deficiency and metabolic syndrome in elderly Chinese individuals: evidence from CLHLS. Nutrition & metabolism. 2020;17:58.
97. Jin JH, Peng H, Zhang Q, Xu J, Kong FL,et al. Association between vitamin D, parathyroid hormone levels and lipid profile in adult residents. Chin Prev Med. 2015(11).
98. Li X, Qu C, Wang Y, Mao Z, Wang C, Li W, et al. Associations of CYP24A1 copy number variation with vitamin D deficiency and insulin secretion. Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme. 2019;44(12):1367-70.
99. Wei QS, Chen ZQ, Tan X, Su HR, Chen XX, He W, et al. Relation of Age, Sex and Bone Mineral Density to Serum 25-Hydroxyvitamin D Levels in Chinese Women and Men. Orthopaedic surgery. 2015;7(4):343-9.
100. Chen F, Wang Y, Guo Y, Wang J, Yang A, Lv Q, et al. Specific higher levels of serum uric acid might have a protective effect on bone mineral density within a Chinese population over 60 years old: a cross-sectional study from northeast China. Clinical interventions in aging. 2019;14:1065-73.
101. Chen QX. Investigation on Vitamin D Nutritional Status and Influencing Factors of Han Nationality Postmenopausal Women in Dongcheng District, Beijing, Doctoral Dissertation.; 2009.
102. Ren Z, Zhao A, Wang Y, Meng L, Man-Yau Szeto I, Yang C, et al. Association of serum 25-hydroxy vitamin D with obesity-related indices in Chinese adults: A cross-sectional study. Food science & nutrition. 2021;9(4):2260-8.

103. Na Mi. Relationship between vitamin D level and thyroid peroxidase level in Qinghai Province.Chin J Endemiol. 2019;38(3).
104. Chen XW, Zhan WH,Yu WQ, Pan JH. Analysis of Vitamin D Nutritional Status of Middle-aged and Old She Nationality Women. Zhejing Medical Journal. 2017;19(8).
105. Hu YC, Chen J, Wang R, Li M, Mao DQ, et al. VITAMIN D NUTRITIONAL STATUS OF CHINESE CHILDBEARING WOMEN. Acta Nutrimenta Sinica. 2020;42(6):537-41.