National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

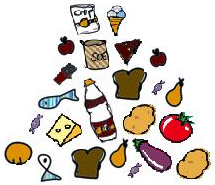
A three-part, mixed effect model to estimate habitual total nutrient intake distribution from food and dietary supplements

Janneke Verkaik-Kloosterman[1], Kevin W. Dodd[2], Arnold L.M. Dekkers[1], Pieter van 't Veer[3], Marga C. Ocké[1]

[1] National Institute for Public Health and the Environment (RIVM)
[2] US National Cancer Institute
[3] Wageningen University

ICDAM 8, Rome, Italy | 15 May 2012

Introduction

Total micronutrient intake →  food + 

dietary supplements

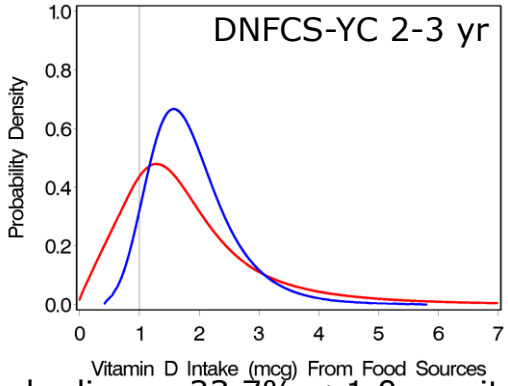
Generally habitual/usual intake is of interest

e.g. to compare with dietary reference values (EAR, UL)

→ statistical correction for

within-person variation to…

retain *between*-person variation



Red line: single diary – 23.7% < 1.0 µg vitamin D

Blue line: two diaries corrected for within-person variation - 7.0% < 1.0 µg vitamin D

Objective

Estimation of *habitual (usual) total* vitamin D intake distribution

Guiding principle:

Habitual *total* intake

=

Habitual intake from food

+

Habitual intake from dietary supplements

as a consequence,

habitual (usual) *total* intake is **always greater than or equal to** habitual (usual) intake from either source alone

Data

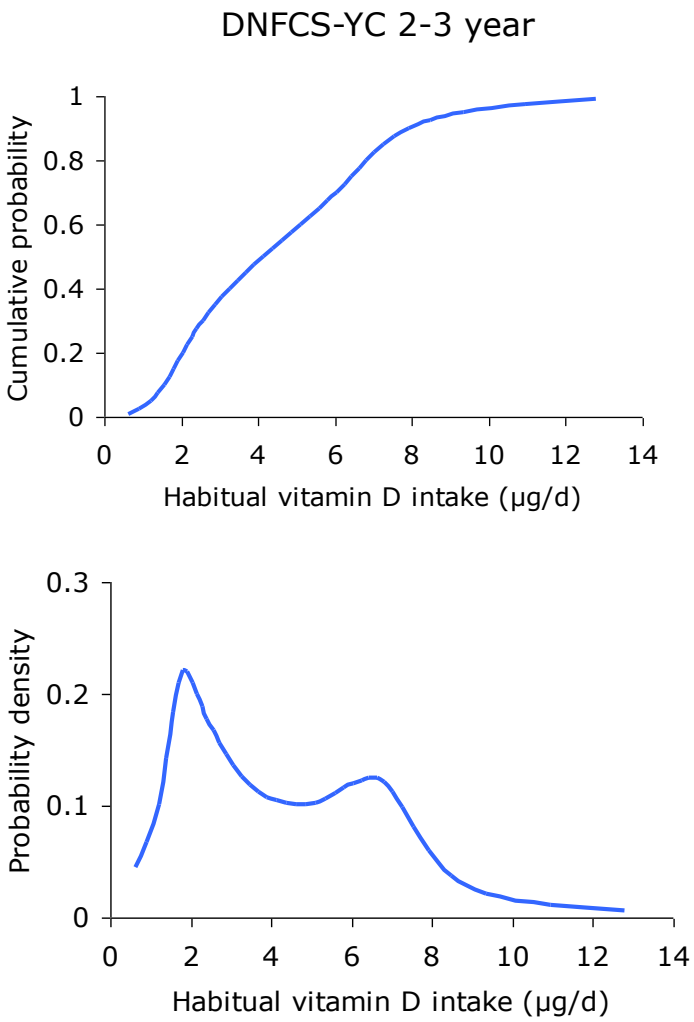
- Dutch National Food Consumption Survey – Young Children (DNFCS-YC) 2005-2006
  - *N=1279* children ages 2-6 year
  - 2 non-consecutive single-day diaries per child
    - food & dietary supplement intake
    - seasonality; weekend/weekday
  - additional questionnaires
    - past month dietary supplement use (Y/N for several types)
- Dutch Food Compostion database (2006, extended version)
- Dutch supplement database

Simplistic approach – 'first add then shrink' (AtS)

- add food intake to dietary supplement intake for each day

person	day	Observed vitamin D µg/day		
		food	supple-ment	total
1	1	4.51	0	4.51
1	2	1.27	0	1.27
2	1	1.97	2.5	4.47
2	2	0.93	2.5	3.43
3	1	2.37	0	2.37
3	2	1.48	3.1	4.58

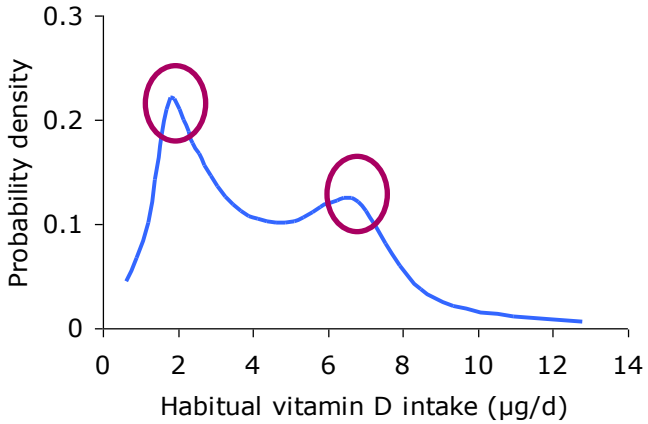
- adjust for within-person variation via ISU-method



Problems applying AtS to vitamin D in DNFCS-YC

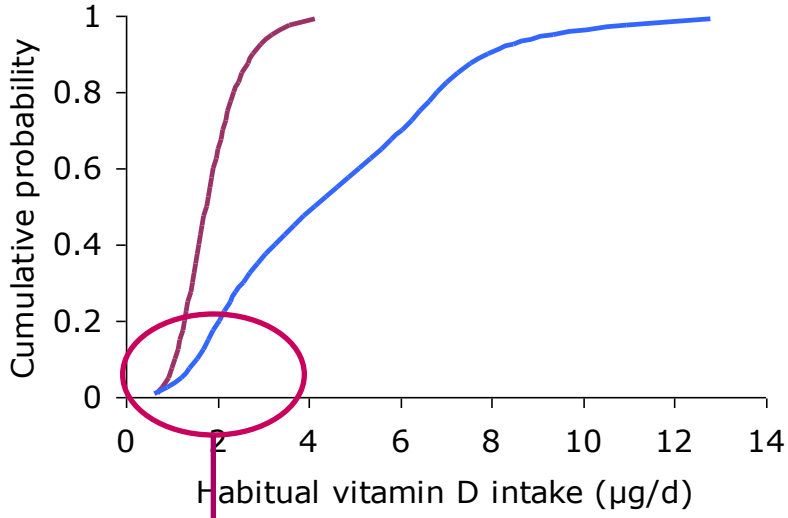
- discrete dosages dietary supplements

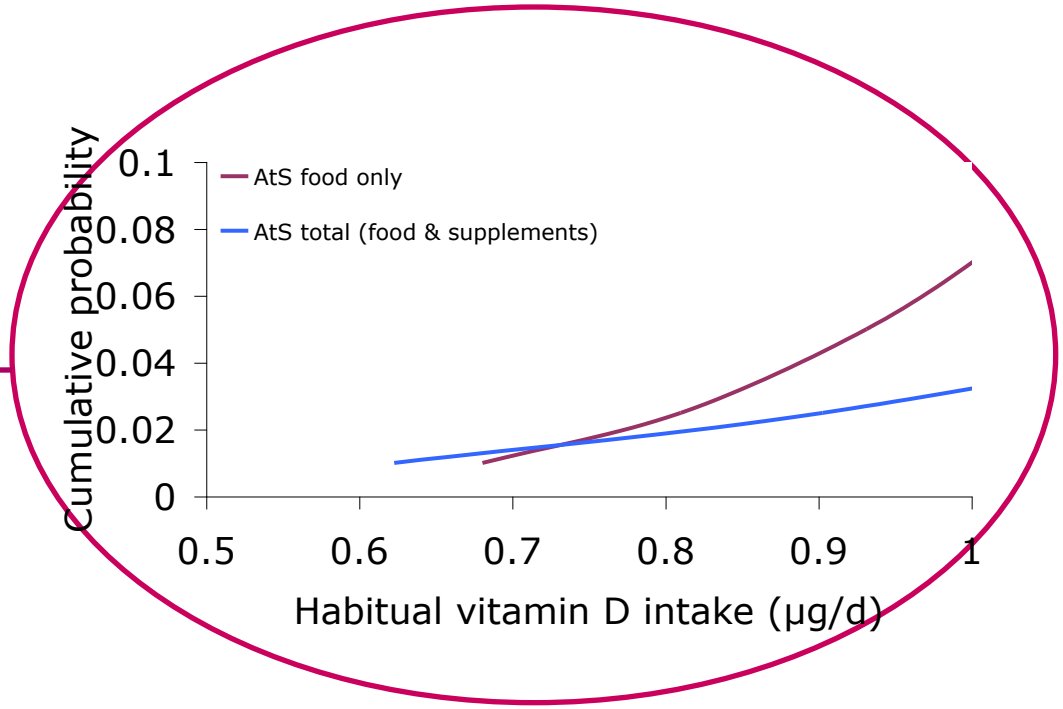
  → multiple modes



- episodic consumption of dietary supplements (DS)
  - highly heterogeneous within-person variances
  - DS-users based on additional questionnaire & 2 diaries
    - 19% of DS-users, in none of the diaries DS use
    - 20% of DS-users, one diary DS use
    - 61% of DS-users, both diaries DS use
    - 15% of DS-users both diaries → ≠ dosages

Inconsistency in leftmost tail – children 2-3 year





habitual total intake estimated to be **less** than habitual intake from food only

‘add then shrink’ is too simplistic

Garriguet (2010)

- Tail inconsistencies can occur quite often
- Proposes separate estimation of habitual intake distributions for users and non-users of dietary supplements

Advantages: differences in food intake users/non-users; correlation intake food & DS for users

Bailey *et al.* (2010); Slob *et al.* (2010)

- Propose separate modeling of habitual intake distributions from food and from dietary supplements – “Shrink then add”

Advantage: differences in variance components taken into account

New method combines elements of both alternatives

Three-part model – schematic overview

Intake from **food sources**

Intake from dietary supplements (**DS)**

***Non-users* DS**

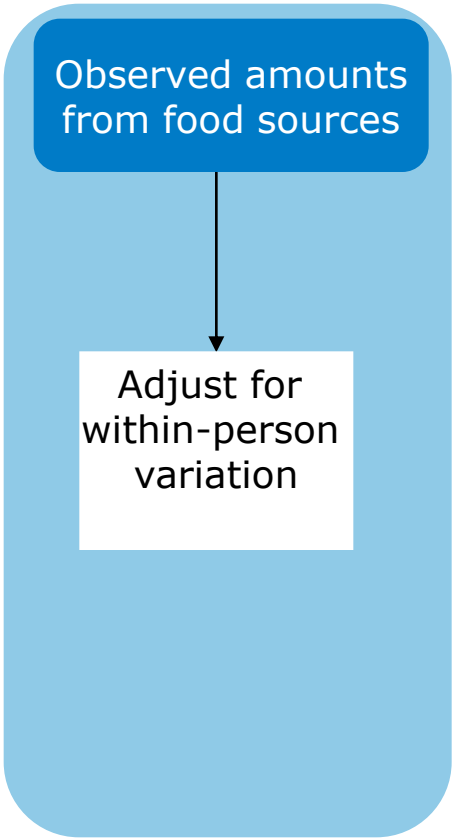
Observed amounts from food sources

Three-part model – schematic overview

Intake from **food sources**

Intake from dietary supplements (**DS**)

***Non-users* DS**

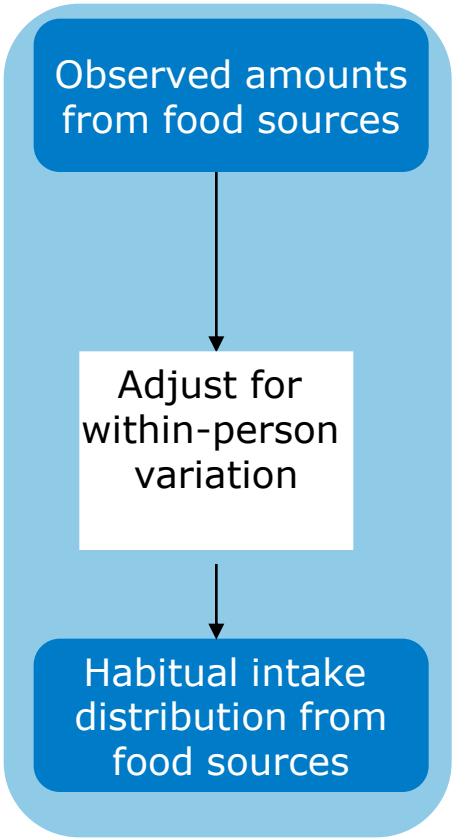


Three-part model – schematic overview

Intake from **food sources**

Intake from dietary supplements (**DS**)

***Non-users* DS**



Three-part model – schematic overview

Intake from **food sources**

Intake from dietary supplements (**DS**)

***Non-users* DS**

Observed amounts from food sources

↓

Adjust for within-person variation

↓

Habitual intake distribution from food sources

***Users* DS**

Observed amounts from food sources

Observed frequency of DS use

Observed dosage on DS use days

Three-part model – schematic overview

Intake from **food sources**

Intake from dietary supplements (**DS**)

***Non-users* DS**

Observed amounts from food sources

Adjust for within-person variation

Habitual intake distribution from food sources

***Users* DS**

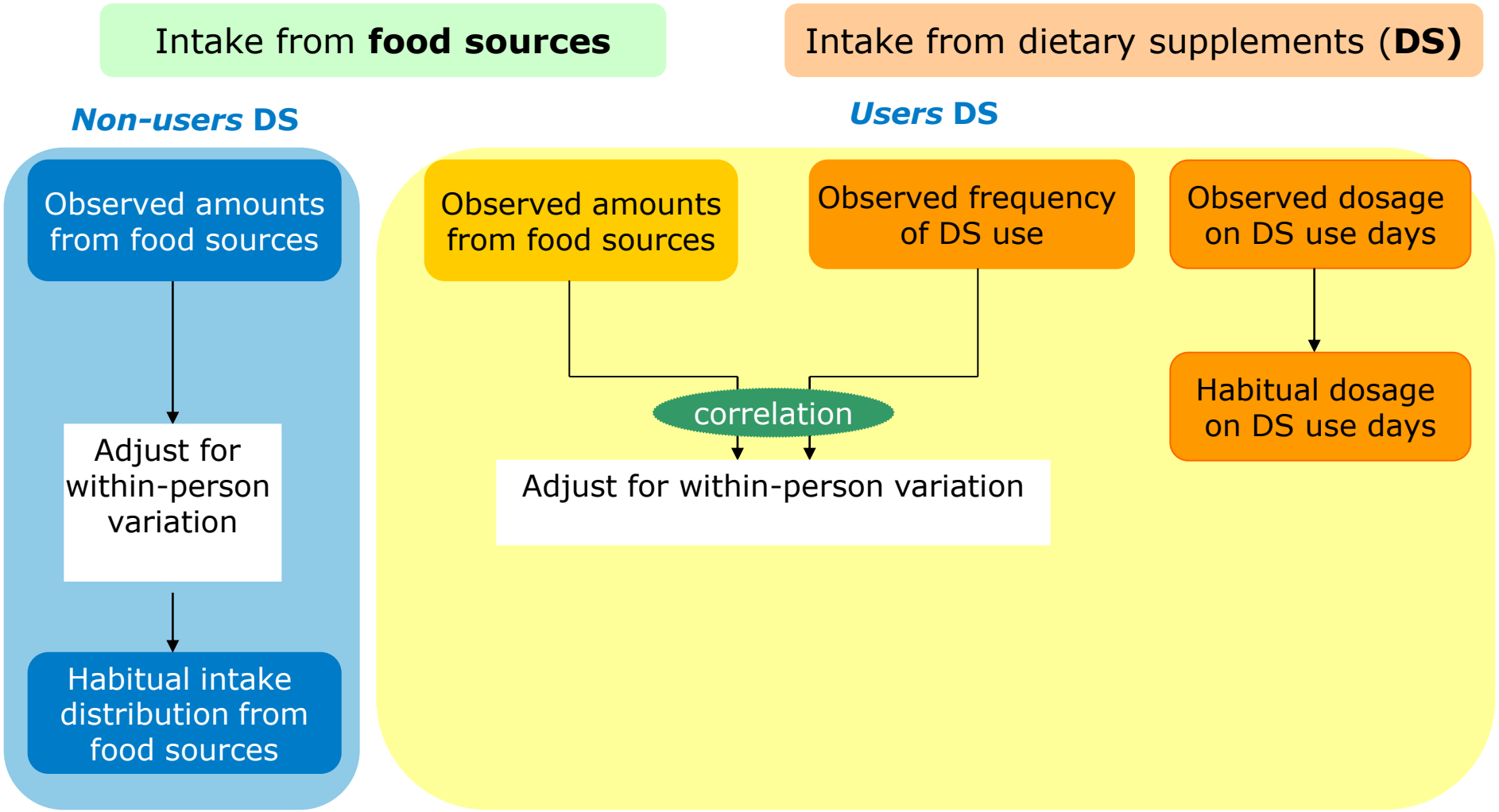
Observed amounts from food sources

Observed frequency of DS use

Observed dosage on DS use days

Habitual dosage on DS use days

Three-part model – schematic overview

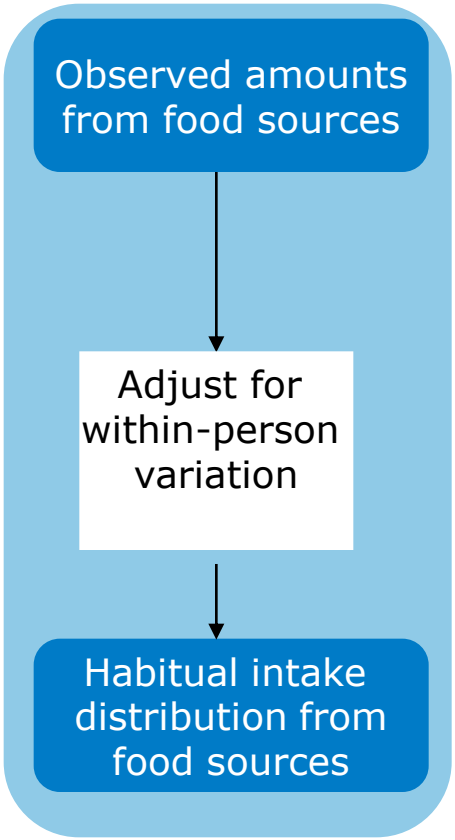


Three-part model – schematic overview

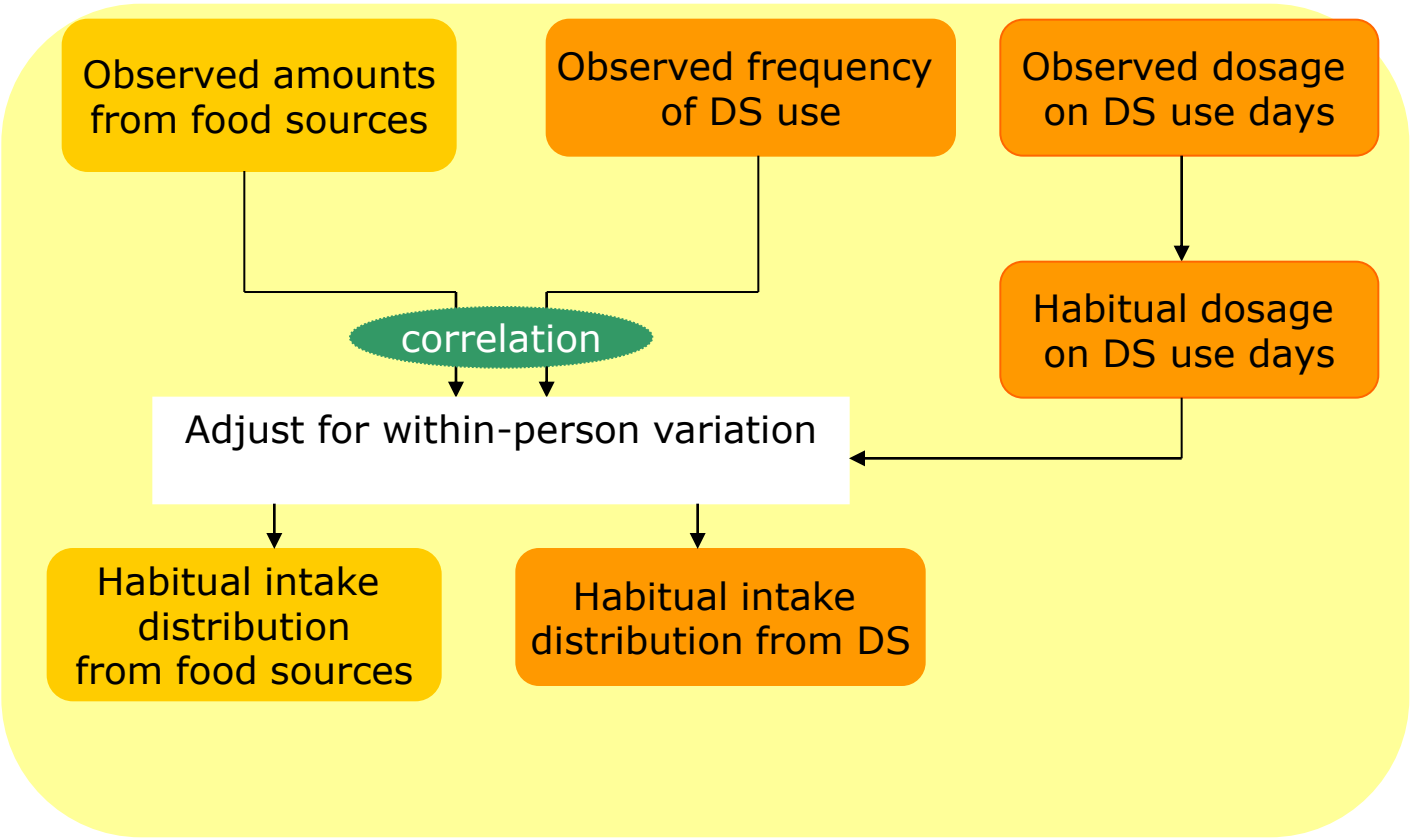
Intake from **food sources**

Intake from dietary supplements (**DS**)

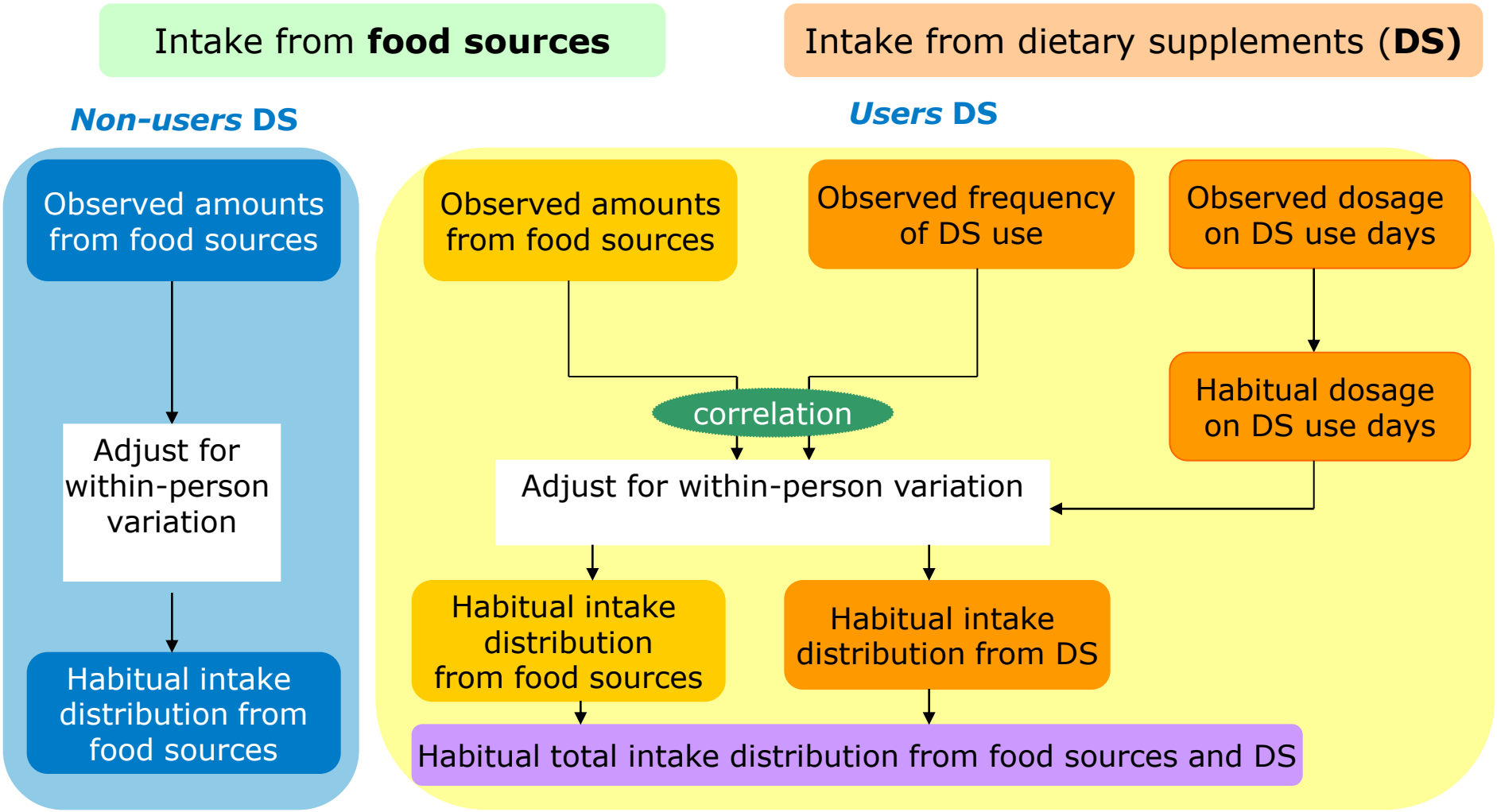
***Non-users* DS**



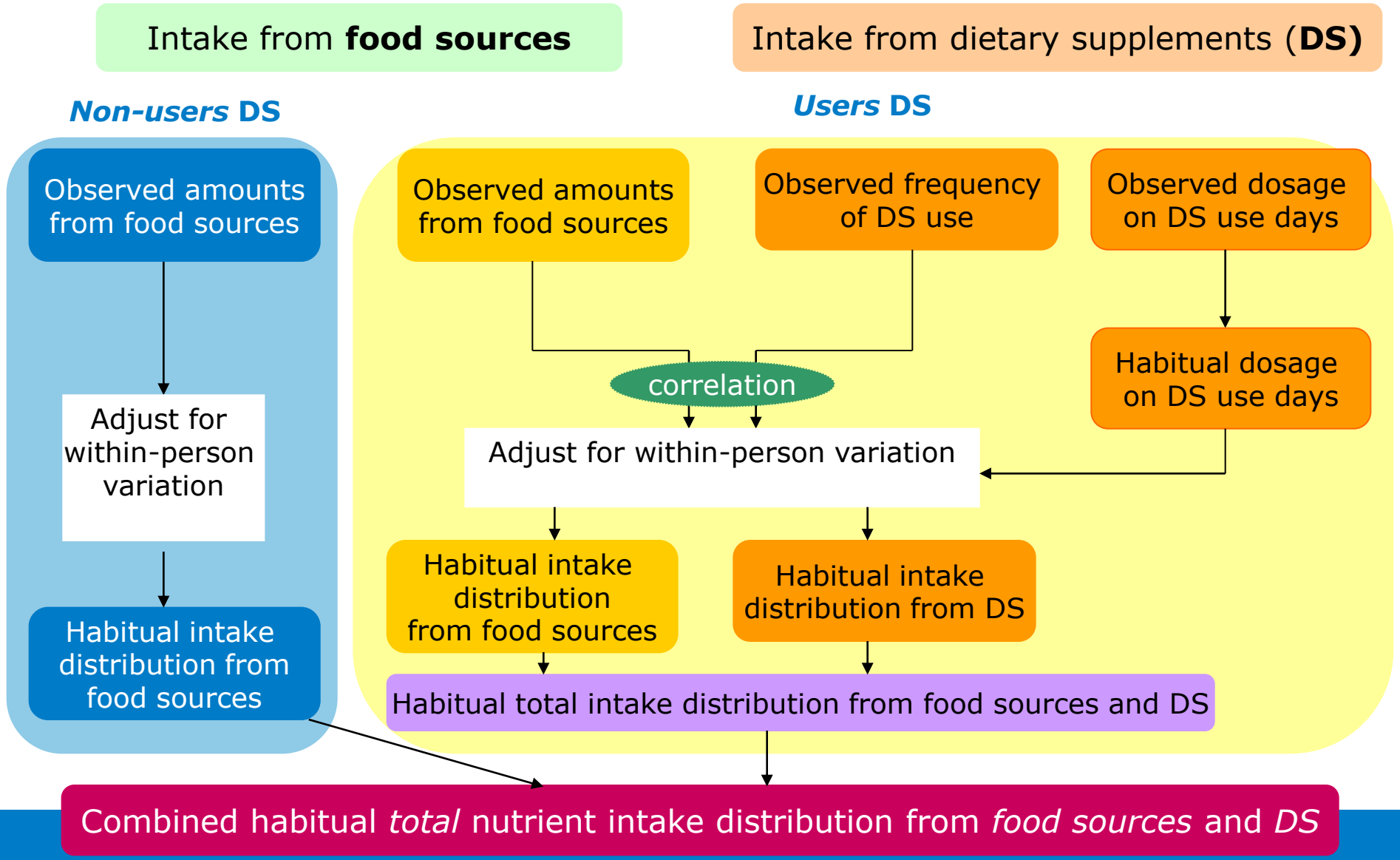
***Users* DS**



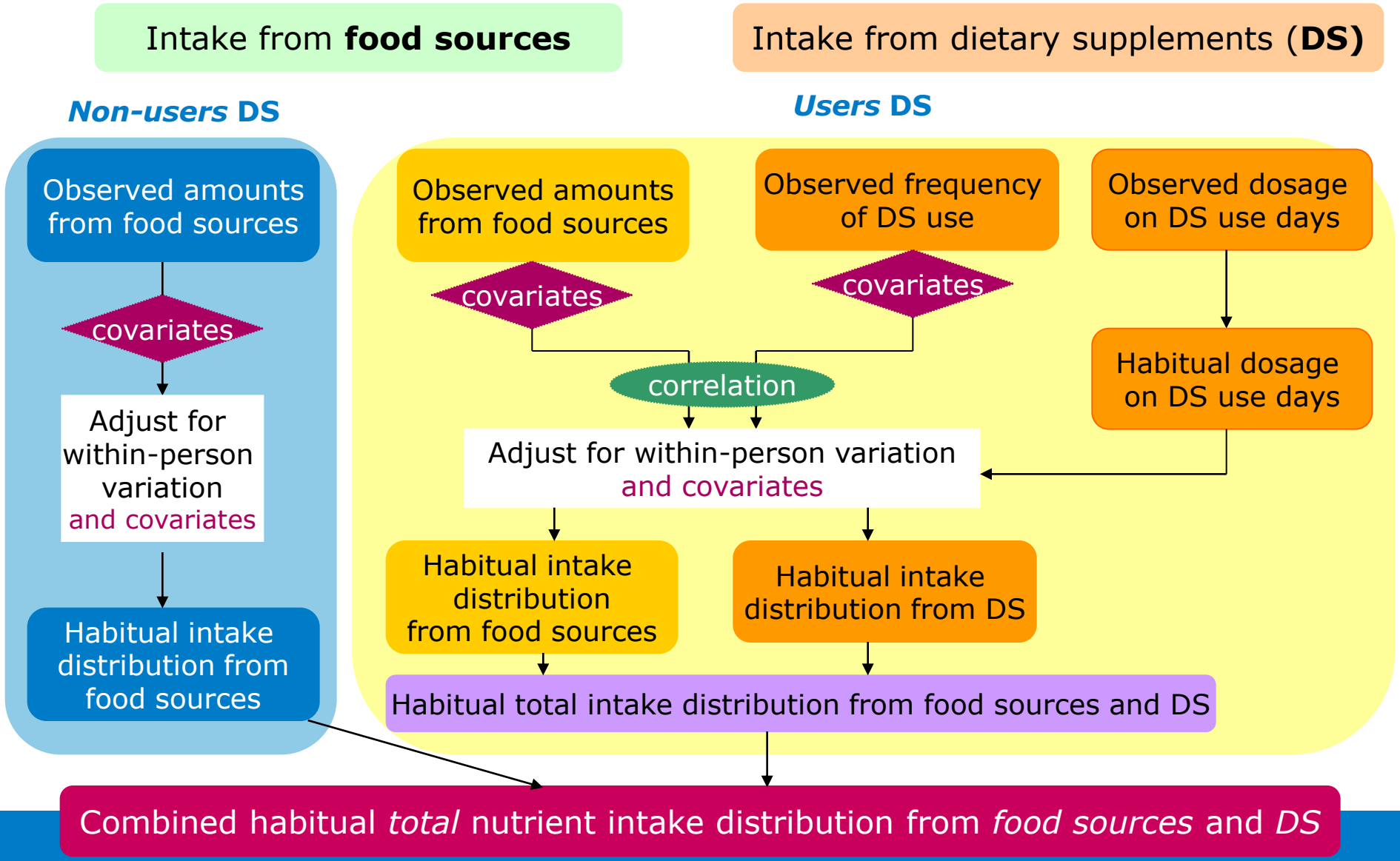
Three-part model – schematic overview



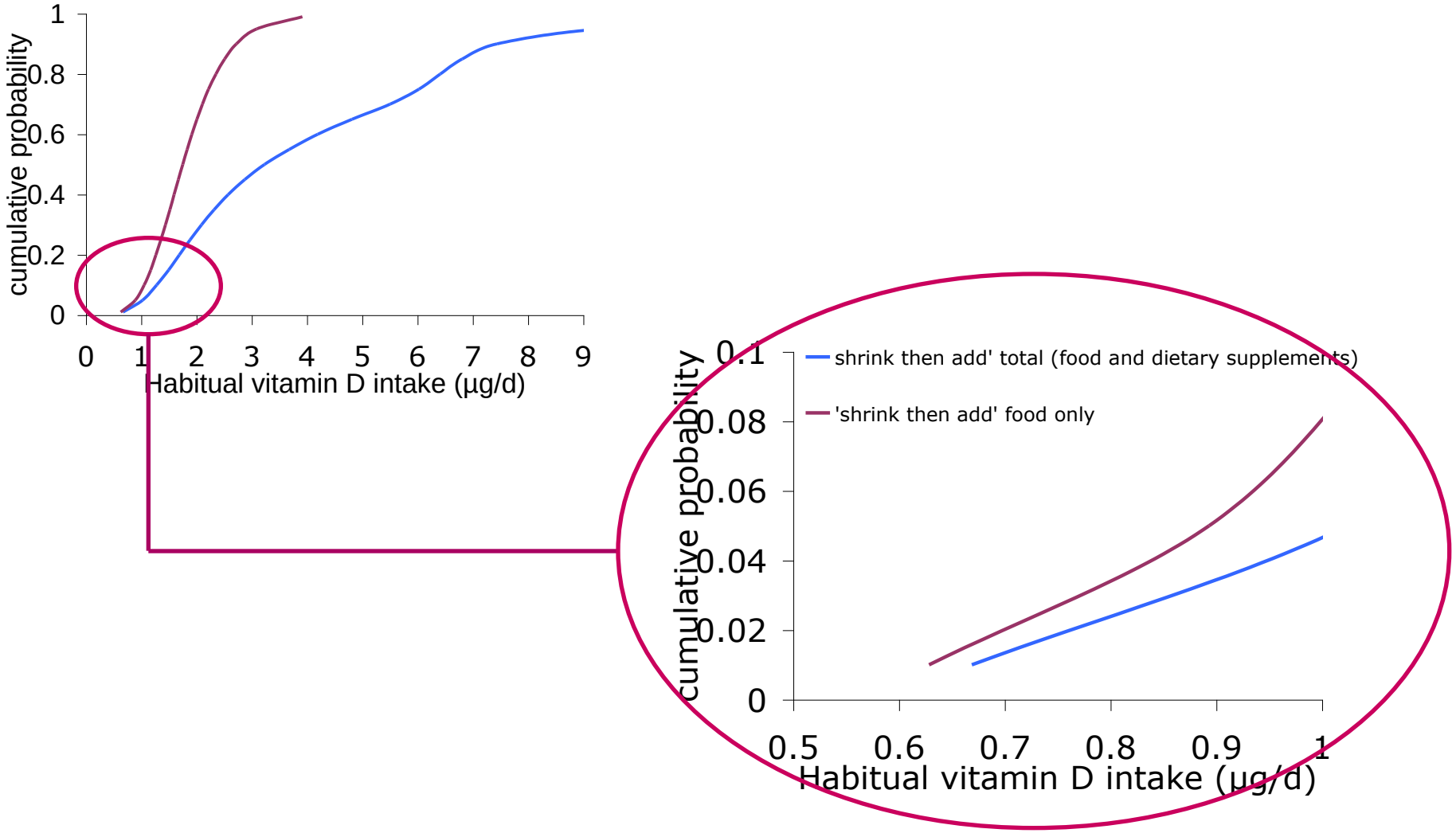
Three-part model – schematic overview



Three-part model – schematic overview



Inconsistency fixed in leftmost tail – children 2-3 yr



Comparison with cut-off points

Proportion of children 2-3 yr with habitual vitamin D intakes below specific cut-off points

Method	Cut-off point (µg vitamin D)							
	1.0	1.5	2.5	3.5	5.0	10	15	25
Shrink then add	4.6	15.1	38.7	53.0	66.4	95.9	99.5	100
Add then shrink*	5.0	11.0	26.7	43.4	64.9	95.1	99.5	100
Difference in percent points	-0.4	4.1	12	9.6	1.5	0.8	0	0

without imputation and covariates

* original NCI-method

Discussion

Three-part model allows:

- modeling multimodal distributions
    - option other multimodality issues e.g. food fortification

- covariates
    - dietary supplement user or non-user
        (additional questionnaire)
    - demographics
    - nuisance effects (e.g. season, weekend/weekday)
    - differential effects in each of 3 parts

- correlation between probability to use dietary supplements and habitual intake from food sources

Discussion

- imputation or other modeling may be required for (known) users of dietary supplements, without dosage information from diaries
- more detailed information on dietary supplement use over longer time period is warranted

- separating users and non users of dietary supplements may reveal differences in habitual intake distribution from food sources
  - within- and between-person variation
  - mean and percentiles

- three-part model developed from original NCI-method in SAS recently also built in SPADE (Statistical Program to Assess Dietary Exposure)

Conclusion

The proposed three-part model is an improvement for the estimation of total nutrient intake distributions from food and dietary supplements

as it
- allows heterogeneous variances
- retains multimodality
- has no inconsistency in leftmost tail of the distribution

A three-part, mixed effect model to estimate habitual total nutrient intake distribution from food and dietary supplements

Janneke.Verkaik@RIVM.nl

Verkaik-Kloosterman *et al.*
J Nutr. 2011; 141(11):2055-63