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Basic principles for assembling, managing and updating a food composition database

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Objectives in developing a national FCDB

- To serve the requirements of the potential users
- Work cost-effective and with timeframe for editions
- Consultation with all interested parties and users
- Disseminate outputs (print, CD, web) widely
- Provide continuous access of all users to the outputs

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Without food composition data countries cannot:

- analyse the nutrient intake or develop nutrient requirements and safe upper limits,
- carry out epidemiological research on nutrient intake and disease,
- produce accurate food labels,
- formulate institutional and therapeutic diets,
- promote nutritionally important plants and animals to improve health or for breeding,
- inform consumers about good food choices.

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Initiation of a FCDB programme

- by government
- by researchers needing food composition data
- by others interested like you

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Food composition programmes need

- Motivated people
- Standard procedures, in line with international guidelines
- Integrated in international network
- Steering committee between users, stakeholders and compilers
- Government support
- Funding for data generation, compilation and dissemination

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Food composition programme

- **Administrative frame**
- **Data generation** (analytical, calculated or estimated data)
- **Data compilation** (in food composition database management system - FCDBMS)
- **Data dissemination** (to users through internet or printed material)
- **Data use** (by knowledgeable professionals)

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Administrative frame

- National Food Composition Steering Committee
- Government Departments and Ministries
- Research Organizations, Universities
- Institutes with food intake data
- Technical Committees
- Dietitians Association / Nutrition Society
- Food Industries / Producer Boards
- Budget
- Secure agency responsibility/authority

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Data Generation principles

- Generation of NVs starting for major foods in the food supply and for nutrients contributing most to nutrient intake
  → selection of main foods and key food approach to select nutrients to be analyzed
- Good sampling plan
- Internationally recommended analytical methods as first priority
- Select GLP laboratory proving to
  - use appropriate analytical methods
  - perform method well
  - uses quality assurance principles, ideally be accreditated for the method and matrix

→ if not done obtain NVs of low quality (with random and/or systematic error) = waste of budget

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What is needed to analyse nutrients?

You need:

- list of foods and nutrients to be analysed (e.g. keyfood approach)
- technical equipment and trained personal, preferable accredited laboratories OR outsourcing to good laboratory
- to produce high quality data take USDA Evaluation criteria into account:
    - Sample plan
    - Sampling handling
    - Number of samples
    - Analytical method
    - Analytical quality control

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Data Compilation Principles (1)

GCP Good compilation practices

- Develop standard criteria for data evaluation and for inclusion of data into DB
- Use FCDBMS
- Document all data
- Use international standards
- Broad coverage of foods and components
- Unambiguous identification of foods and components
- Be systematic and able to explain your data and data choice

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Data Compilation Principles (2)

Use international standards on:

- food description, terminology, nomenclature and classification
- nomenclature of nutrients and other components
- food composition database management and data interchange formats
- recipe calculation and information management
- documentation, standardization and evaluation procedures

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Issues for FCDB (1)

Food level:

- number of foods covered
- language
- food identification- classification-description systems,
- level of detail in the food description
- brand name coverage
- representativeness of nationally consumed foods including unique foods
- food numbering (indicating food group and sequential numbering within)

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Issues for FCDB (2)

Component level:

- component coverage
- identification
- definitions
- units and denominators
- modes of expression
- sampling scheme
- Reference analytical method per component per matrix or food group

Value level:

- extent and treatment of missing
- documentation (source, analytical methods, definition, fortification, food sampling, statistical data etc)

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Issues for FCDB (3)

Database management issues:

- compilation, e.g. calculation procedures
- software capacity
- standardization and evaluation
- quality index
- international data interchange
- terminology
- publication policies
- food legislation
- copyright
- budget

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Software

A specific software is needed for FCDB manager to handle:

- documentation
- standardization
- evaluation
- compilation
- calculation
- performing basic statistic
- manage analytical data information
- importing, exporting and printing files (common specific formats)

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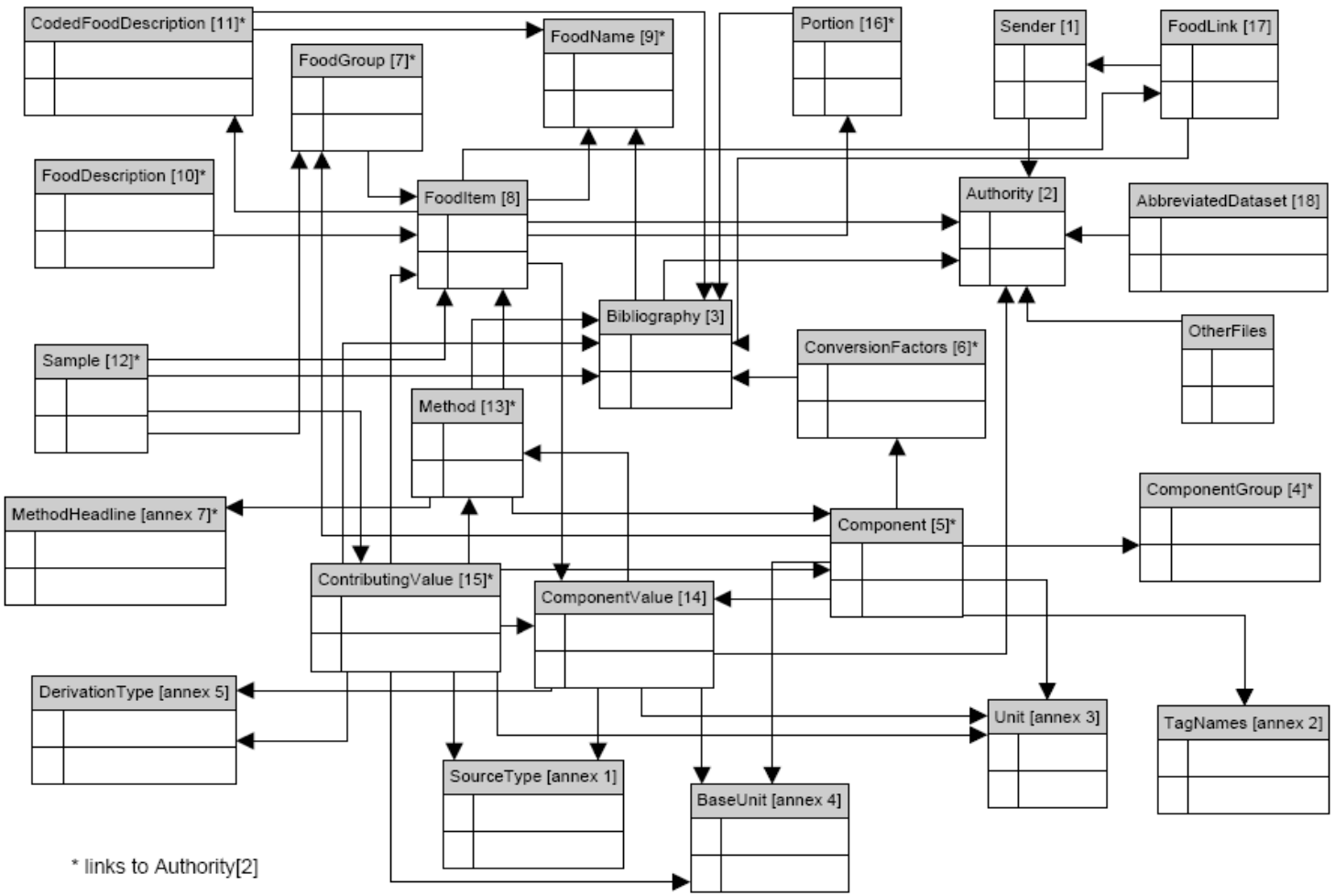
ER diagram



* links to Authority[2]

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Different levels of databases

1. Assembling data sources
2. Archival records
3. Reference database
4. User database

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What is done before compiling a database

- selection of foods (number, description, inclusion of brandname food etc)
- selection of nutrients and other components
- priorities are set
- user steering group established (ideally)
- operational plan (at least draft)
- budget allocation
- authorization for national FCDB (if adequate)

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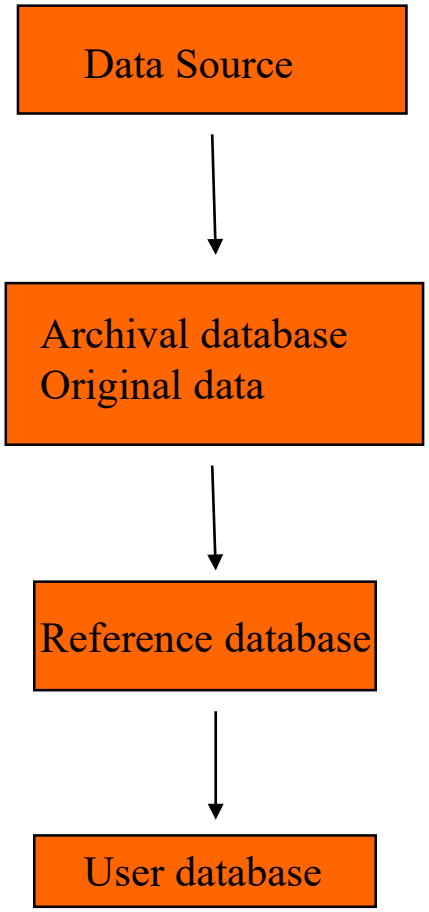
Data flow in FCDBs



Collect data (paper, electronic)

Evaluate data against a set of criteria and assign quality

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Assembling data sources

Collect available data

- Analytical data (own, other)
- other FCDB
- literature, incl. scientific articles
- other databases
- food industry
    - unpublished data, e.g. university, institutes

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Primary publications

- Nutrition and Food Science: (top 10 hits on Food Composition)
  - Food Chemistry
  - Journal of Agricultural and Food Chemistry
  - Journal of Food Composition and Analysis
  - Journal of Nutrition
  - American Journal of Clinical Nutrition
  - Journal of the Science of Food and Agriculture
  - European Journal of Clinical Nutrition
  - British Journal of Nutrition
  - Journal of Dairy Science
  - Journal of Food Science and Technology
  - ……..
- Agricultural/'Crop':
  - The Journal of Dairy Research
  - Horticultural Science
  - African Crop Science Journal
  - Potato research
  - Cereal Sciences
  - ……

Source: Paul Hulshof

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Secondary publications

- national food composition tables and databases (FCDB)
- regional FCDBs, e.g. LATINFOODS, ASEANFOODS, Pacific Island
- international FCDB, e.g. Carotenoids and Food Preparation: The retention of provitamin A carotenoids in prepared, processed and stored foods. Delia B. Rodriguez-Amaya, PhD, 1997
- posters
- non-peer reviewed publications
- label information and data from manufacturers

➔ partially documented and not always suitable for national FCDB

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Differences in foods available in the British, Danish and French tables (editions before 2001)

	raw			cooked			Processed (frozen, canned, dried, etc)		
	UK FCT	French FCT	Danish FCT	UK FCT	French FCT	Danish FCT	UK FCT	French FCT	Danish FCT
Potatoes	11	3	5	42	5	3	2	1	2
Vegetables	108	37	76	109	31	0	49	18	25
Pulses	22	2	8	24	6	2	17	3	2
Fruits	55	40	51	14	1	0	26	16	14
Nuts	30	15	19	5	0	0	1	0	0
Bread/crispbread	52	10	23	7	0	0	0	0	0
Rice/pasta	17	6	5	14	4	1	0	0	0
Flour/grain	27	20	9	1	0	0	0	0	0
Breakfast cereals	32	7	5	0	0	0	0	0	0

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And a lot more .....

- Module 7 of the Food Composition Study Guide
- appendix 7 of the 2. edition of the Greenfield and Southgate book including references on analytical methods, quality assurance, compilation, interchange.....
- ...and the websites of INFOODS http://www.fao.org/infoods/index_en.stm and EuroFir http://www.eurofir.org/eurofir_aisbl/products

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Nutrient composition from labels

Problems

- not all products have a nutrient composition on label
- only macronutrients and nutrients with claim or fortification
- NV can be higher than on label because at end of shelf life still label concentration
- uncertain quality of data

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Nutrient composition from products

Solutions

- calculate other nutrients → difficult as no info on quantities of each ingredient. But USDA has programme for estimation
- estimate from other FCDBs → problem because product composition can change between countries
- contact manufacturer → will not give recipe but rather compositional data. But many do not cooperate. Tendency positive

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Limitations of data coming from different sources

- Journals only accessible after subscription (exception AGORA journals, accessible after registration with FAO)
- Food analysis driven by (very specific) research question
- Food often not representative for what is consumed
- Food description and identification often poor
- Problem of coverage (Foods, nutrients, components)
- Quality (representativeness, sampling, analytical)?
- On label, only limited information of unknown quality
- in different formats
- Up to date?

Source: Paul Hulshof

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Which data are to be assembled?

Mandatory

- the foods and components with their meta data selected for user database
- stock original data with their food nomenclature and code, component identification and modes of expression

Optional

- collect additional components if stated
- collect data on less important foods

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Evaluation Criteria	Clearly acceptable	Progressively decreasing acceptability	Usually unacceptable [a]
Sampling Criteria			
Identity of food and component	Unambiguous	Identity becomes less clear	Any ambiguity
Representativity	Indigenous to the database population	Less representative of the foods consumed	Not stated
Number of samples	Protocol designed to achieve defined confidence limits	Sample numbers chosen arbitrarily	Selective samples, or very limited in number
Nature of material analysed	Clearly defined	Definitions becoming less clear	Not stated or unclear
Analytical sample preparation	Described in detail and known to be conserve nutrients	Described briefly, but still known to conserve nutrients	Not stated, or no evidence of need to protect nutrients in sample

Source: Greenfield & Southgate, 2003

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Criterion	Clearly acceptable	Progressively decreasing acceptability	Usually unacceptable [a]
Analytical criteria			
Choice of analytical method	Well–established and internationally compatible	Less well described or unpublished modifications	Not stated
Performance of method	Established, validated in collaborative trials	Established, but not validated in-house	Not stated, or not known to be adequate. Possibly superseded by better method
Quality assurance	Described, or referenced. Use of proper standards and SRMs	No record of quality assurance, replicate analyses only.	Not stated
Mode of expression	Units and methods of calculation clearly stated	Progressively less-clearly described	Units and factors not given

a)Where the values are the only ones available it may be useful to archive the data

Source: Greenfield & Southgate, 2003

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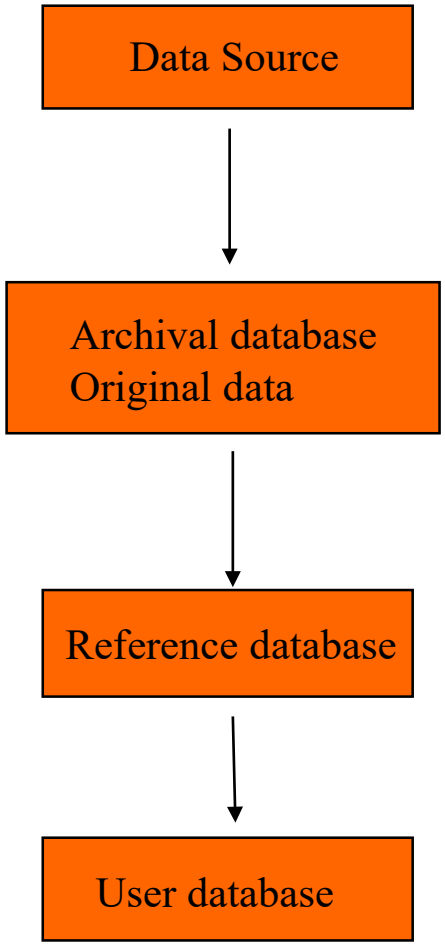
Data flow in FCDBs



Collect data (paper, electronic)

Evaluate data against a set of criteria and assign quality

Enter assembled data in archival DB incl.
own analytical data

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Archival record

Includes ONLY original data from different sources as found there

Tasks

- Select format and means where to stock data and meta data
- Select common modes of expression
- Select preferred analytical methods
- Set up sampling and analytical protocol

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Archival record format

- best option:
  - use computerized database management system
- second best option:
  - use access database
- third best option:
  - use excel spread sheets, e.g. INFOODS/FAO Compilation Tool (at http://www.fao.org/infoods/software_en.stm)
- least optimal option
  - use paper documentation, e.g. predefined fields per food

- avoid compilation without documentation (you will truly regret it later on)

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Documentation and quality index

To assign a quality index data and their documentation are needed in the FCDB on:

- food nomenclature
- component identification and mode of expression
- sampling
- sample handling
- number of samples
- analytical methods
- analytical quality assurance
- reference of source
- if aggregated foods record weighting factors, source of individual foods, type of data etc
- criteria on quality assessment of compilation

➔ safe time if done properly from the beginning

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Documentation

- a must for newly analyzed data
- possible for assembled data
- often impossible for historic data

➔ documentation is essential for data quality and data evaluation

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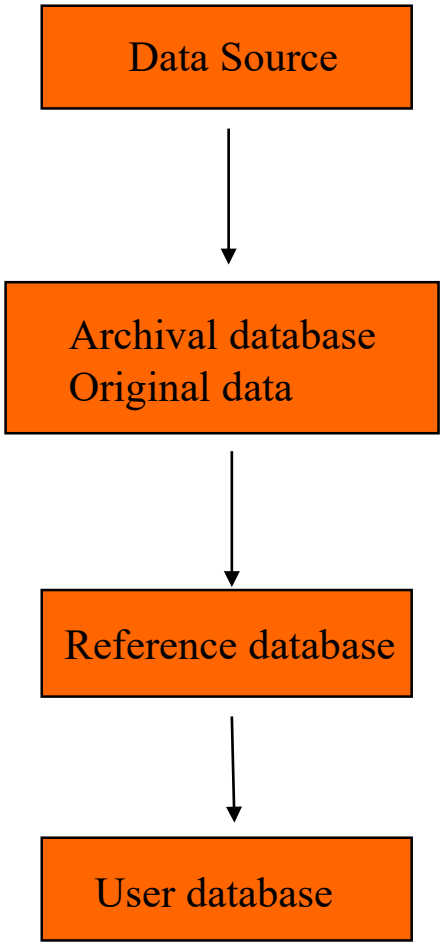
Data flow in FCDBs



Collect data (paper, electronic)

Evaluate data against a set of criteria and assign quality

Enter assembled data in archival DB incl.
own analytical data

Aggregate, calculate, estimate, compare and evaluate data, and complete missing data

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Reference database

Tasks (1)

- Set criteria for
  - aggregating foods and values
  - calculation through algorithms, recipes
  - estimation of values from a similar food
  - final data quality
  - order of external sources for inclusion to FCDB
  - for updating existing data

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Reference database

Tasks (2)

- Compare your data with those from other sources
- Look for inconsistencies
- Attribute quality codes
- Calculation through algorithms, recipes or means
- Estimate values from a similar food
- Presumed zero where adequate
- attempt for no missing values for core nutrients

➔ document all steps

Tasks when comparing data

- assurance that food is the same or as similar as possible
- assurance that nutrient identity, mode of expression and units are the same
- compare water, protein and fat content
- record statistical parameters (mean, median, SD, min, max, number of samples)
- check consistency of nutrient per nutrient within food group

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Calculation

1. Calculation procedures based on recipes for missing complex foods (e.g. cakes, sauces, or soups) for missing cooked foods

- transform NVs from raw to cooked foods
- calculate NVs of recipes
- needed:
    - weight of raw and cooked recipe or yield factors for the recipe
    - retention factors for all nutrients and main cooking methods
    - recipe calculation system
    - programme/file to manage the calculation (e.g. https://www.foodcomponline.info)

2. Calculation procedures to adapt to water, fat, protein contents between foods

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Caution when copying values

Make sure that it is

1. same food
- taxonomic name, same variety
- meat cut
- same fat, water, protein content
- same brand name can have different composition
- fortification??

2. Same nutrient
- comparable definition
- comparable analytical method
- same expression (CHO as monosach. or sum of fraction)

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Guide for acceptable analytical ranges in nutrient values

- ± 1.5%: CHO, fat, water, protein, nitrogen, fibre, alcohol, ash,
- ± 10%: cholesterol, water soluble vitamins, minerals
- ± 20%: fat soluble vitamins, carotenes
- ± 25%: trace elements (natural variation up to 2 or 3 orders of magnitude)

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Examples for internal checks (1)

- check sum of macronutrients come to 100g (recommended 97-103g: acceptable 95-105g):
  - Water + available carbohydrates + fat + fibre + protein + alcohol + ash = 100.
  - Water + total carbohydrates + fat + protein + alcohol + ash = 100.
- Absence of alcohol, starch, fibre, cholesterol, retinol in specific food categories, etc
- The sum of soluble carbohydrates and starch is equal to available carbohydrates.
- Animal + plant protein = total protein
- Animal + plant fat = total fat
- Haem + non haem iron = total iron

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Examples for internal checks (2)

- Sum of saturated, monounsaturated and polyunsaturated fatty acids is equal to total fatty acids but less than total fats (< 95%)
- If total fats are equal to zero, also fatty acids are equal to zero, no fatty acid conversion factor exists (or =1.0?), and cholesterol is equal to zero.
- Oleic acid is less or equal to total monounsaturated fatty acids
- linoleic acid < sum of polyunsaturated fatty acids
- Sum of individual fatty acids belonging to a fraction is equal or below the value of the corresponding fraction.
- check component identification, units and modes of expression

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Examples for internal checks (3)

- Water + DM ≈ 100
- ash ≥ Σ minerals (where K and P values should be multiplied by 3)
- Fortification levels
- The vitamin content of processed foods should be lower than of the corresponding raw food (except when fortified)

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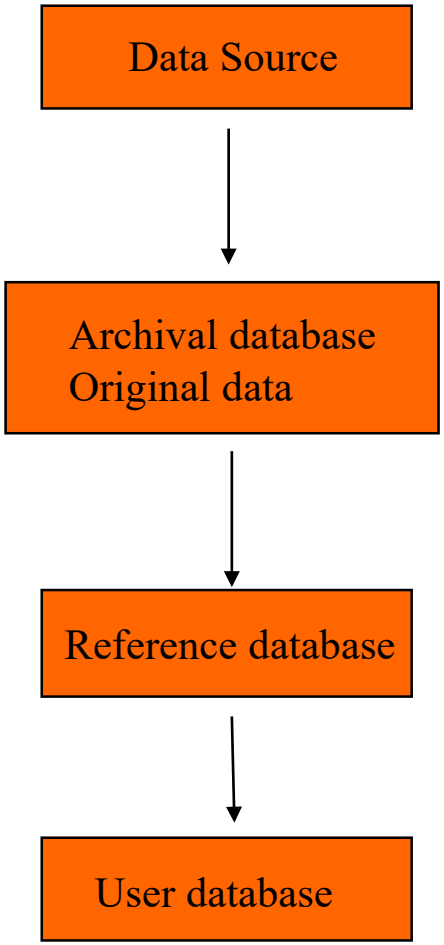
Data flow in FCDBs



Collect data (paper, electronic)

Evaluate data against a set of criteria and assign quality

Enter assembled data in archival DB incl. own analytical data

Aggregate, calculate, estimate, compare and evaluate data, and complete missing data

Select of foods and components for user database

Publish concise or comprehensive user database or table – printed, electronic

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User databases

Different formats/databases according to users' needs

- Comprehensive (includes many foods and components and meta data) for researchers
- Abbreviated/abridged (a smaller set of foods and components, normally without metadata but general documentation) for general public
- special use DB covering specific components, e.g. phytoestrogenes
- complete DB (no missing values) for food intake studies

➔ all different output formats from the reference database

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User Database formats

- Table: 2-dementional, normally with limited documentation, printed or computerized
- Database: multi-dimensional, computerized with extensive documentation and metadata

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Data dissemination

- Electronic databases (concise or comprehensive)
  - Excel, Access, MySQL, PostgresSQL or similar – most recommended
  - PDF – additionally to Excel etc. but not alone
- Via internet
- Printed tables – yes but not alone. Better together with Excel etc and PDF
- Free of charge or with fee
- Copyright issue
- Intervals of new editions, e.g. every 5 years

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Thoughts on copyright

- every compiler of FCDB uses literature sources which are based on expensive studies but which have no copyright

➔ where is the difference between data from literature and FCDB?

➔ why would a FCDB with mainly imported data have the right to copyright this FCDB?

➔ why not move FCDBs, developed with public funds, to the public domain, e.g. USDA

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Updating a FCDB (1)

New foods (or new NV of existing foods):

- New varieties of plants
- Changes in animal husbandry and butcher practices
- New manufactured foods (or new fortification levels)
- Changing consumption patterns
- Changes in marketing and distribution
- New ingredients (or NVs) of recipes
- genetically modified foods

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Updating a FCDB (2)

Adding nutrients

- because of new evidence of health and disease associations or other public health interest:
  - Fatty acids
  - Trace minerals
  - Anti-oxidants
  - Other plant constituents
- new or changes in food legislation, e.g. AOAC fibre instead of NSP, or protein (which is always calculated based on nitrogen) now for all foods Nx6.25

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Updating a FCDB (3)

Replacing nutrient values, for example:

- improved analysis of nutrients
  - Dietary fibre
  - Folates
- new convention for equivalents, e.g. vitamin A equivalent
- new analyzed values (to replace copied NV)
- new food legislation

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How can you find out about the quality of your DB?

1. Use the FAO/INFOODS Evaluation Framework to Assess the Quality of Published Food Composition Tables and Databases (2021)
2. Evaluation of food composition data according to established evaluation criteria (e.g. USDA, EuroFIR)
3. Comparison of your procedures, foods and nutrients with other FCDBs and standards (e.g. FAO/INFOODS)
4. Comparison of foods in your FCDB and foods consumed in your country, e.g. reported in national surveys
5. Comparison of nutrients and other components in your FCDB with needs of users and with other published values

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Evaluation Categories and Criteria

- Sampling Plan
- Sample Handling
- No of Samples/Standard Deviation
- Analytical Method
- Analytical Quality Control

each of 5 categories has specific questions with 20 points coming to 100 points total

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Additional Evaluation Categories for data quality used by EuroFIR and in Greenfield & Southgate (2003)

- Food description and identification

- Component identification

→ sometimes necessary to contact author of source to obtain needed information

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FAO/INFOODS Evaluation Framework to Assess the Quality of Published Food Composition Tables and Databases (2021)

1. 8 screening questions. If passed, then full evaluation
2. Full evaluation according to 7 categories

Nr.	Category	Nr. of criteria
1	Documentation in the FCT/FCDB to inform users	11
2	Food coverage	5
3	Food identification	3
4	Component and value coverage and component expression	2
5	Quality of data – analysis- the compilation process and checking	7
6	Public access of FCT/FCDB	5
7	Year of publication and frequency of updates	2

3. Final score: Quality scoring of the entire FCT/FCDB and per criteria: high- medium- insufficient

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Results Overview

Screening questions

brief first evaluation,
if positive – continue

PART 1

PART 2

Full evaluation

In depth evaluation
7 detailed categories
Several sub- criteria

Final score

Quality scoring of the entire FCT/FCDB and per criteria:
high- medium- insufficient

PART 3

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Results II

Part 2 Full evaluation

Nr.	Category	Nr. of criteria
1	Documentation in the FCT/FCDB to inform users	11
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How to make data compatible for regional FCDB?

Once all data are documented (sampling, analytical method, source etc) use common rules to:

--> standardize data (definition, analytical method, unit etc.)

--> evaluate data
- discard unacceptable data
- replace old or doubtful data

--> complete missing data
- analyse data
- calculate NVs of important foods
- estimate missing single values

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Limitations of food composition data

- only average values, never exactly reflecting the composition of any single food
- Missing data (missing foods, missing components and missing values) in most FCDBs:
  - rarely several food entries for the same food on different varieties, geographic areas, season, maturity, processing etc.
  - rarely include manufactured foods, fortified foods and vitamin and mineral supplements
- Not represent foods consumed in the country when values are imputed, calculated or borrowed, or if of low analytical quality or based on few samples
- Missing documentation makes it impossible to assess the quality of the data
- The data may not be comparable over time and across countries

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Nowadays, can we only work nationally?

What are the advantages and disadvantages?

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Advantages to work internationally

- use international standards - no need to re-invent the wheel
- others might have thought about things that did not yet occur to your mind
- possibility to interchange data and ideas
- you know that you are not alone, even you might be in your country
- source of information and support
- any other??

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Disadvantages to work internationally

- need to change what was done before, or add
- takes longer to agree
- any other??

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International Consultations and Collaborations

- Standards for food composition (food and component nomenclature, data quality, interchange, FCDBMS)
- Reference materials
- Interlaboratory trials
- Capacity development: training courses and material, assistance to countries
- Examples of networks
    - INFOODS with its regional data centres in collaboration with FAO/UNU
    - EuroFIR

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Recommendations

- Strengthen national programs; maintain national identity
- Integrate national activities into existing networks, e.g. INFOODS and contribute actively to regional and/or international activities
- Compile national data into a database
- Participate in international standard developments and data sharing
- Identify areas requiring more assistance (e.g. training/equipment for data generation, compilation, dissemination) and approach funding agencies with good proposal
- Provide food composition input into Codex and food safety activities

For more on food composition, visit www.fao.org/infoods