TEETH IN BIOANTHROPOLOGY

DEPARTMENT OF ANTHROPOLOGY

Teeth & Genetic & Movement

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SPRING 2024

PART 1.

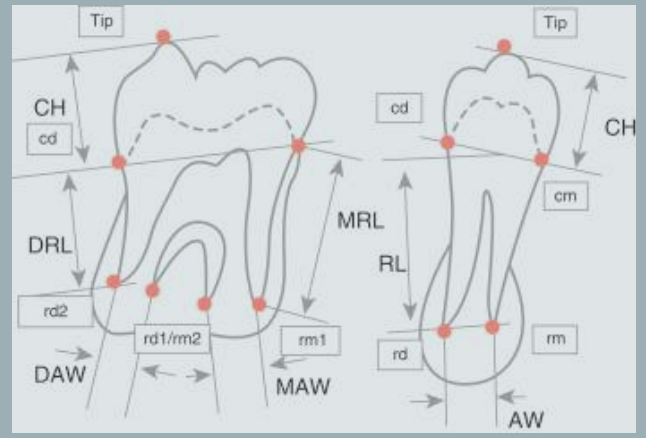
TEETH & ANCESTRY

METHODS

Metric dental traits

Non-metric dental traits

Ancient DNA



WHAT YOUR TEETH SAY ABOUT YOUR ANCESTRY

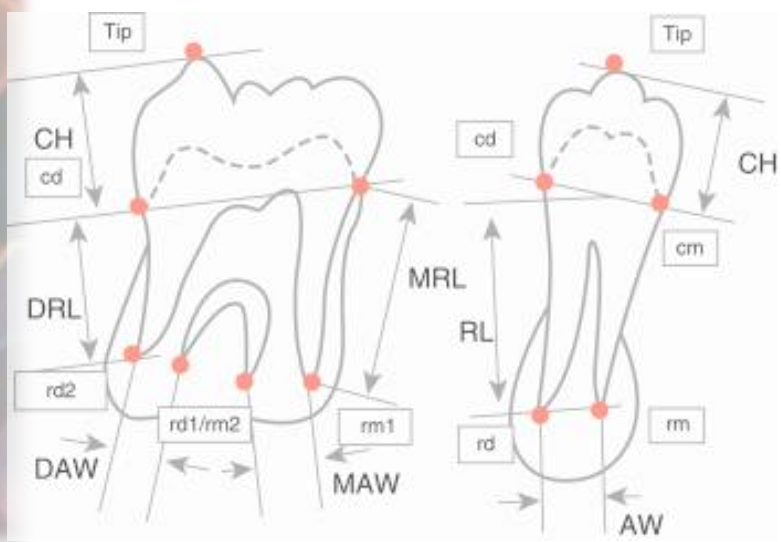
The shape, configuration and landscape of each person's teeth are unique to them

Your teeth are shaped by your genetics and then altered and worn by the food you eat and how you live your life

Your dentist can tell a lot about your personal health and diet from your teeth, and sometimes your teeth also offer clues to your heritage

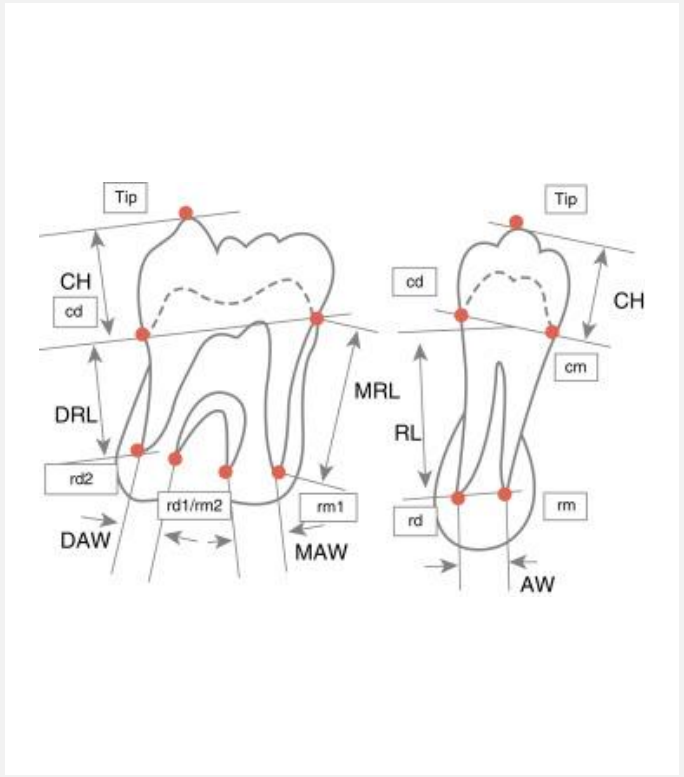
METHODS

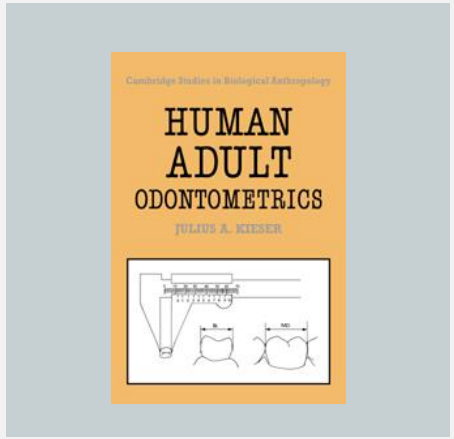
1. Metric dental traits
2. Non-metric dental traits
3. Ancient DNA



METRIC VARIATIONS: ODONTOMETRY

* Tooth measurements
* Most common indicators:
  - Tooth height
  - Mesiodistal diameter
  - Buccolingual diameter
  - Crown module
* Used for age & sex estimation

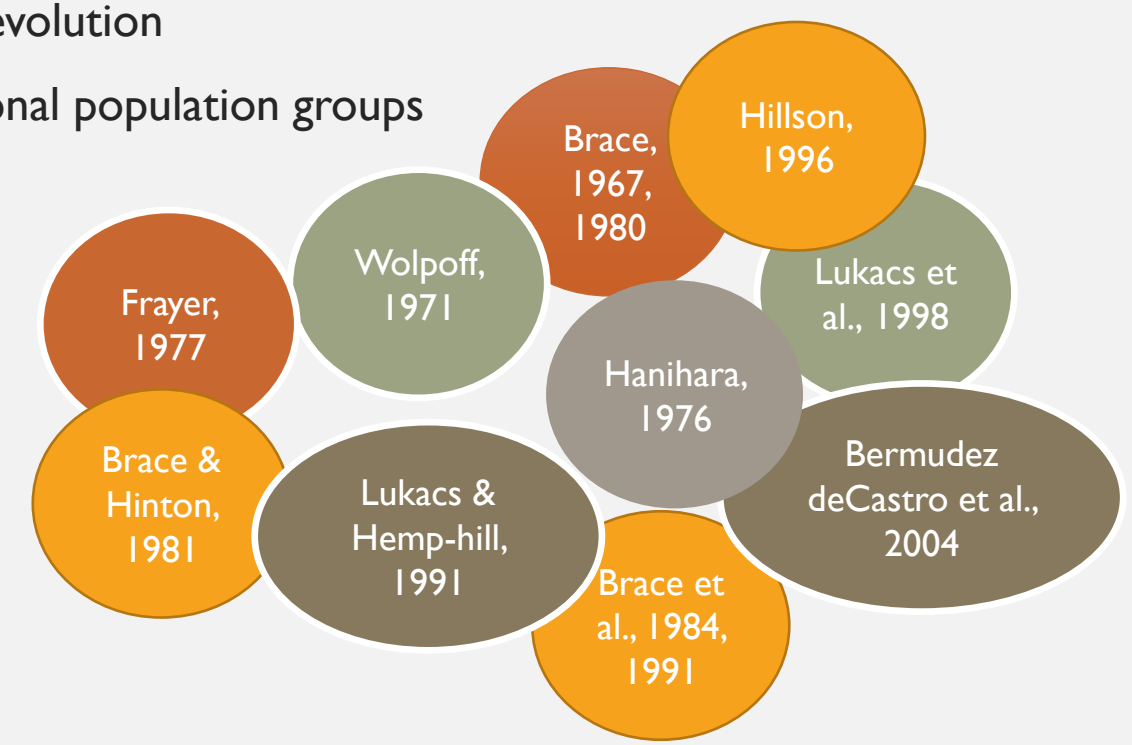




METRIC VARIATIONS

Often used in:

1. investigation of hominid evolution
2. diversity of localand regional population groups



DURING THE PAST FEW DECADES

Some articles on metric dental variation were published:

1. covering a wide range of regional populations (*Lasker & Lee,1957; Falk & Corruccini, 1982; Harris & Bailit, 1988; Kieser, 1990; Schnutenhausand Ro ̈sing, 1998*)
2. classified contemporary & recent populations as microdontic, mesodontic, and megadontic (*Harris and Rathbun, 1991*)

AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 128:287–298 (2005)

Metric Dental Variation of Major Human Populations

Tsunehiko Hanihara[1*] and Hajime Ishida[2]

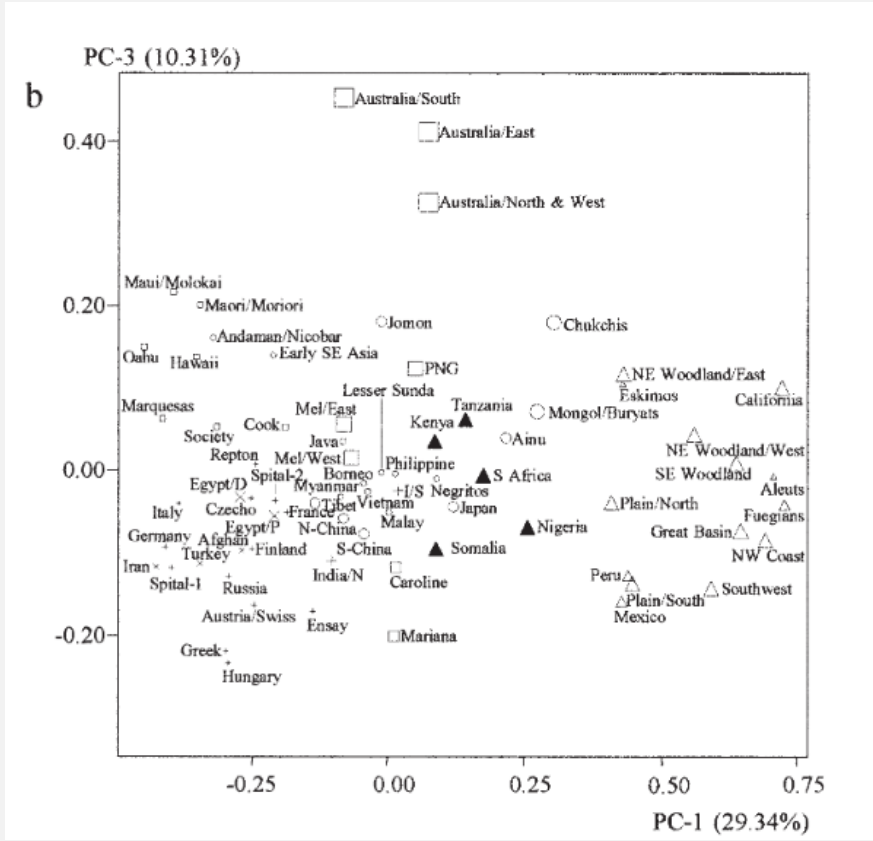
[1]*Department of Anatomy and Biological Anthropology, Saga Medical School, Saga 849-8501, Japan*
[2]*Department of Anatomy, Faculty of Medicine, University of the Ryukyus, Nishihara, 903-0215, Japan*

KEY WORDS odontometrics; phenotypic diversity; geographic variation; interpopulation relationships

ABSTRACT Mesiodistal and buccolingual crown diameters of all teeth recorded in 72 major human population groups and seven geographic groups were analyzed. The results obtained are fivefold. First, the largest teeth are found among Australians, followed by Melanesians, Micronesians, sub-Saharan Africans, and Native Americans. Philippine Negritos, Jomon/Ainu, and Western Eurasians have small teeth, while East/Southeast Asians and Polynesians are intermediate in overall tooth size. Second, in terms of odontometric shape factors, world extremes are Europeans, aboriginal New World populations, and to a lesser extent, Australians. Third, East/Southeast Asians share similar dental features with sub-Saharan Africans, and fall in the center of the phenetic space occupied by a wide array of samples. Fourth, the patterning of dental variation among major geographic populations is more or less consistent with those obtained from genetic and craniometric data. Fifth, once differences in population size between sub-Saharan Africa, Europe, South/West Asia, Australia, and Far East, and genetic drift are taken into consideration, the pattern of sub-Saharan African distinctiveness becomes more or less comparable to that based on genetic and craniometric data. As such, worldwide patterning of odontometric variation provides an additional avenue in the ongoing investigation of the origin(s) of anatomically modern humans. Am J Phys Anthropol 128:287–298, 2005.

RESULTS OF THE STUDY

1. Australians have the largest teeth and Western Eurasians have small teeth
2. In terms of odontometric shape factors, world extremes are Europeans
3. East/Southeast Asians share similar dental features with sub-Saharan Africans
4. Patterning of dental variation among major geographic populations is consistent with genetic and craniometric data
5. Pattern of Sub-Saharan African distinctiveness is comparable to that based on genetic and craniometric data



Scattergrams of 1st & 2nd PC scores (a) and 1st & 3rd PC scores (b), based on C-score data.

J Int Oral Health. 2015 Sep; 7(9): 83–87.

PMCID: PMC4589727

PMID: 26435624

Assessment of Ethnicity in Indian Population using Tooth Crown Metric Dental Traits

V Deepak,[1] S N Goryawala,[2] Yashwanth Reddy,[3] R J Chhabra,[4] Nandaprasad,[5] and Nishit Kumar Shah[6]

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Abstract

Go to: ▸

Background:

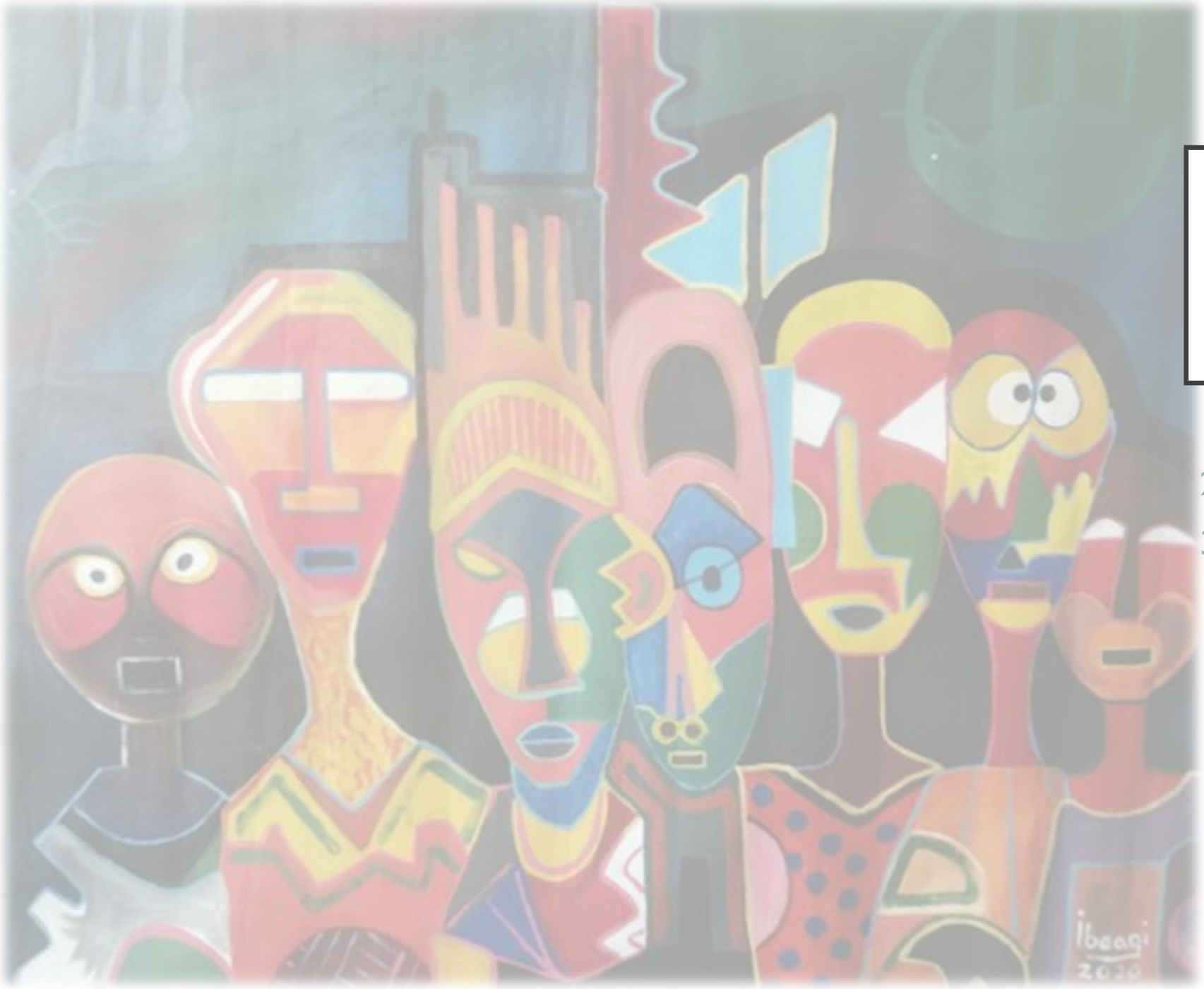
Tooth crown dimensions vary between different ethnic groups, providing insights into the factors controlling human dental development. This present study compares permanent mesiodistal (MD) and buccolingual crown dimensions between four ethnic groups, highlighting patterns of tooth size between these groups and considers the findings in relation to genetic and environmental influences.

Materials and Methods:

MD and buccolingual tooth crown dimensions were recorded using digital vernier calipers on dental casts derived from four different human population: Iranians, Hindus, Muslims, and Christians.

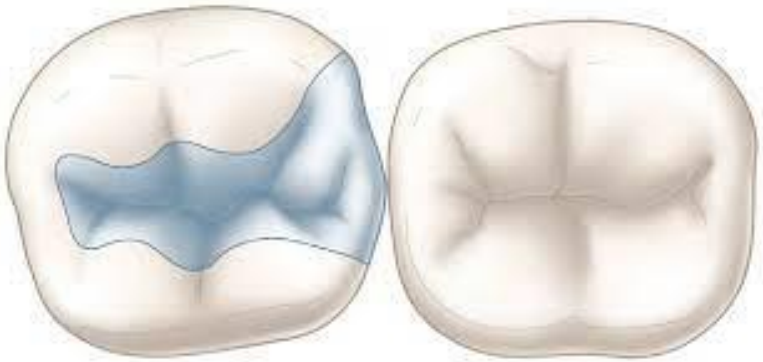
Results:

Obtained measurements were subjected to statistical analysis. The Christian sample was found to have the largest teeth overall, whereas the Iranian sample generally displayed the smallest MD and buccolingual crown dimensions ($P < 0.001$). Comparisons of coefficients of variation for teeth within each class showed that the later-forming teeth displayed greater variation in MD size than the earlier-forming teeth.



METHODS

1. Metric dental traits
2. Non-metric dental traits
3. Ancient DNA



FACT!

All human dentitions are basically the same. The differences between individuals are in the number and extent of the primary and secondary characters of the tooth groups, which in turn are the reflections of the genetic constitution of the individual.

- Dental non-metric traits have become widely used to estimate biological affinities

METHOD

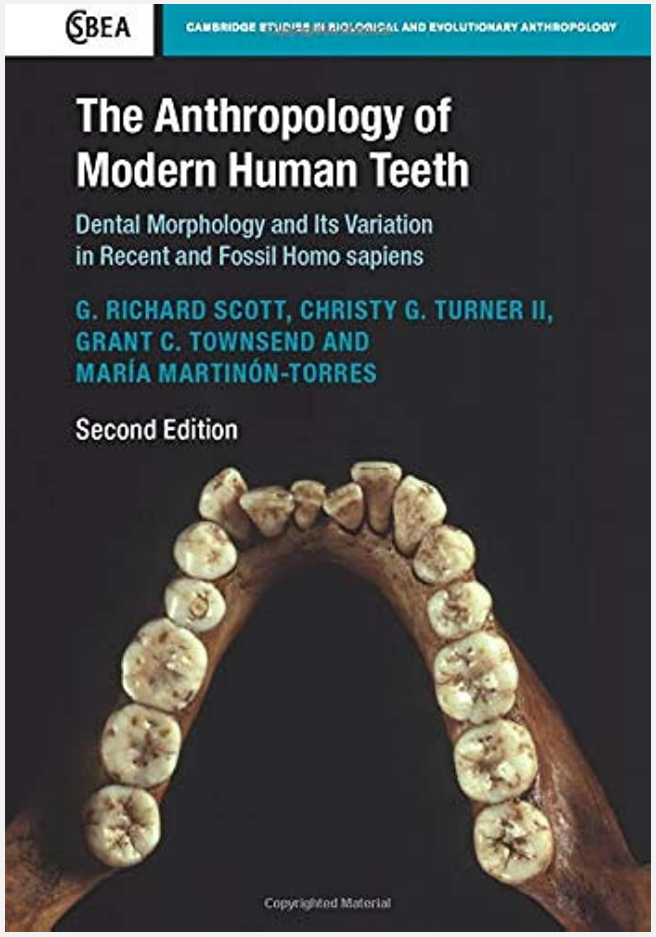
The Arizona State University Dental Anthropology System (ASUDAS)

METHODS

The Arizona State University Dental Anthropology System (ASUDAS)

++ Statistical approach

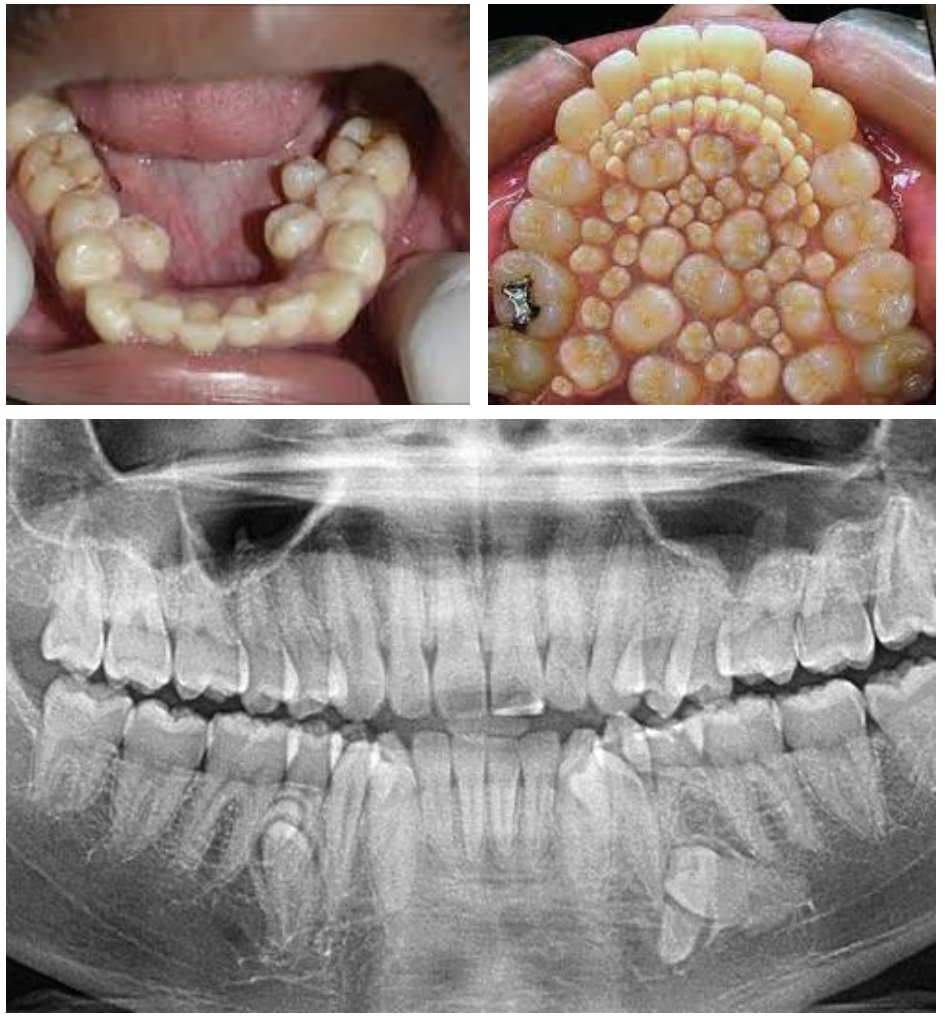
THIS BOOK IS NOT A METHODOLOGICAL GUIDE FOR SCORING CROWN AND ROOT MORPHOLOGY



VARIATIONS IN TOOTH NUMBER & POSITION

VARIATION 1

What is this?



1. SUPERNUMERARY TEETH

are defined as those in addition to the normal series of deciduous or permanent dentition. They may occur:

- anywhere in the mouth
- as a single tooth or multiple teeth,
- unilaterally or bilaterally,
- erupted or impacted
- in mandible/maxilla or both the jaws

VARIATION II

What is this?

VARIATIONS IN TOOTH NUMBER & POSITION

Congenital absence of teeth CMT (hypodontia) is when one or more teeth normally present in the dentition will be missing.

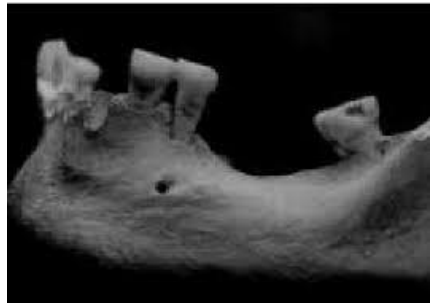
1. "oligodontia" is used for six or more missing teeth
2. "anodontia" for complete absence of teeth

- The 3rd molars are the most frequently missing

VARIATIONS IN TOOTH NUMBER & POSITION

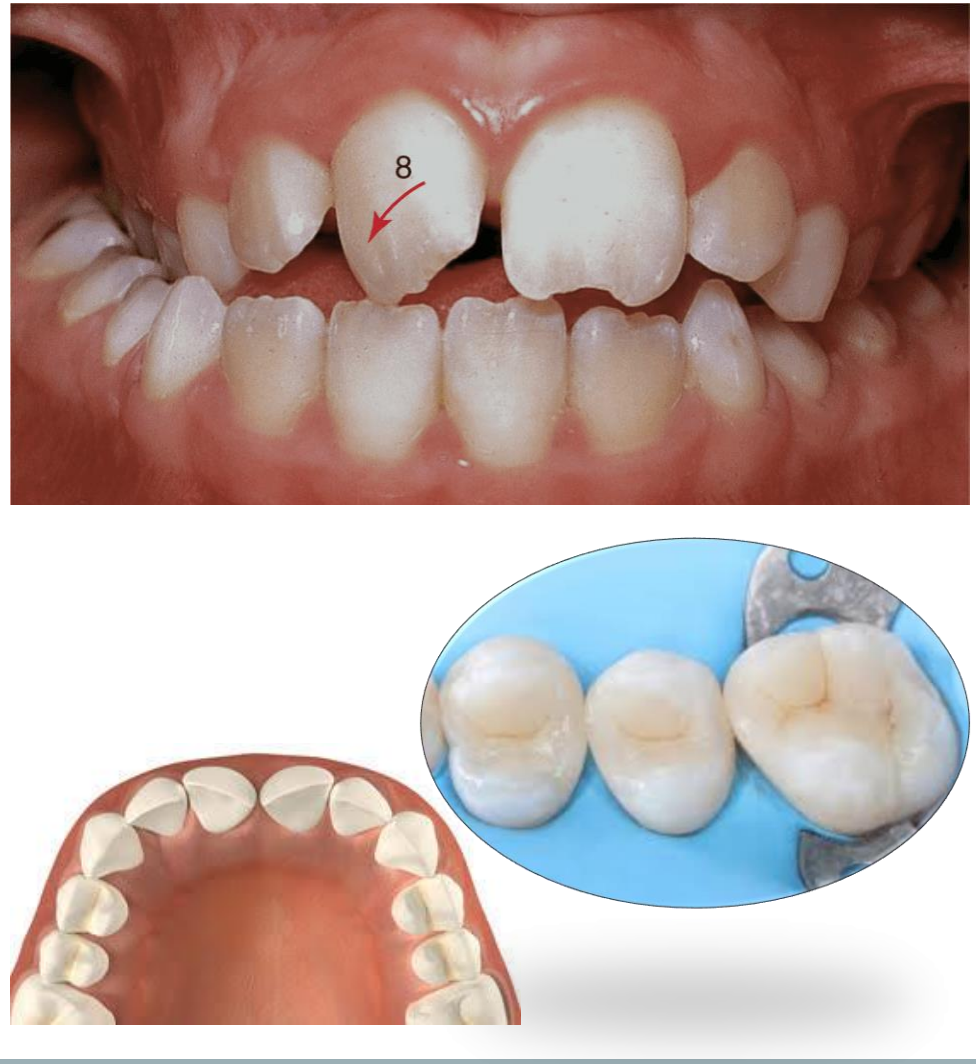
Congenital absence of teeth CMT vs Antemortem tooth loss ATM

- ✓ detected by the characteristic distorted and unequal appearance of the alveolus



VARIATION III

What is this?



VARIATIONS IN TOOTH NUMBER & POSITION

Rotation of teeth is defined as observable mesiolingual or distolingual intra alveolar displacement of the tooth around its longitudinal axis

- Most often second premolars but it is possible for any tooth!

VARIATION IV

What is this?

VARIATIONS IN TOOTH NUMBER & POSITION

Crowding of teeth is the lack of space for all the teeth to fit normally within the jaws.

The teeth may be twisted or displaced.

It occurs when there is:

- ✓ disharmony in the tooth to jaw size relationship,
- ✓ teeth are larger than the available space

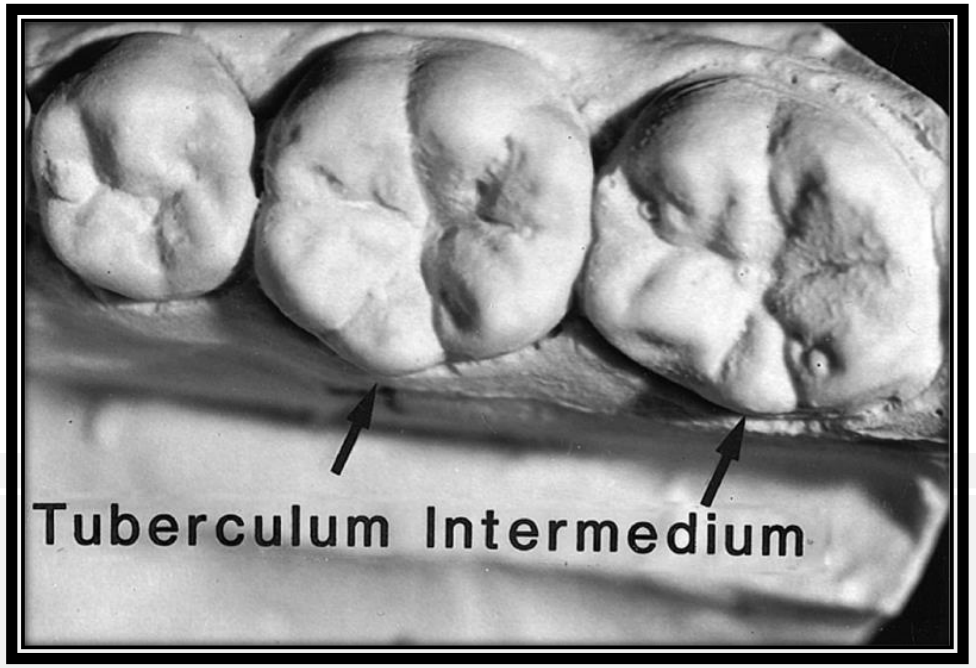
VARIATIONS IN TOOTH NUMBER & POSITION

1. Supernumerary teeth
2. Congenital absence of teeth CMT
3. Rotation of teeth
4. Crowding of teeth

VARIATIONS IN TOOTH MORPHOLOGY

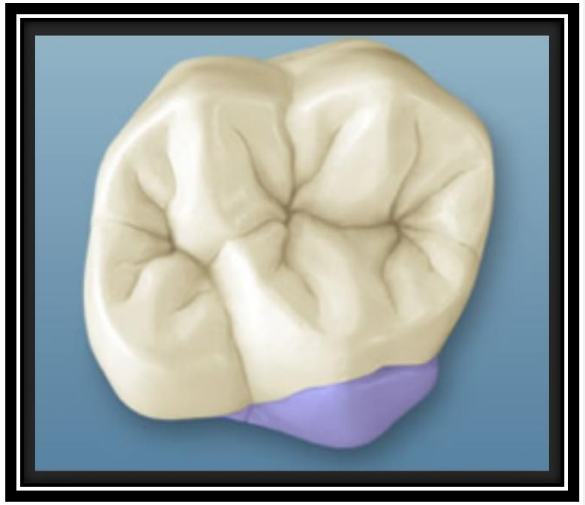
1. EXTRA CUSPS

- A third lingual cusp may develop on mandibular molars
- Called tuberculum if on the lingual surface
- Called tuberculum sextum If on the distal marginal ridge



2. CUSP OF CARABELLI

- A small additional cusp at the mesiopalatal line angle of upper molars (1st)
- Concerned molars have 2 roots instead of 3
- Mostly in European populations

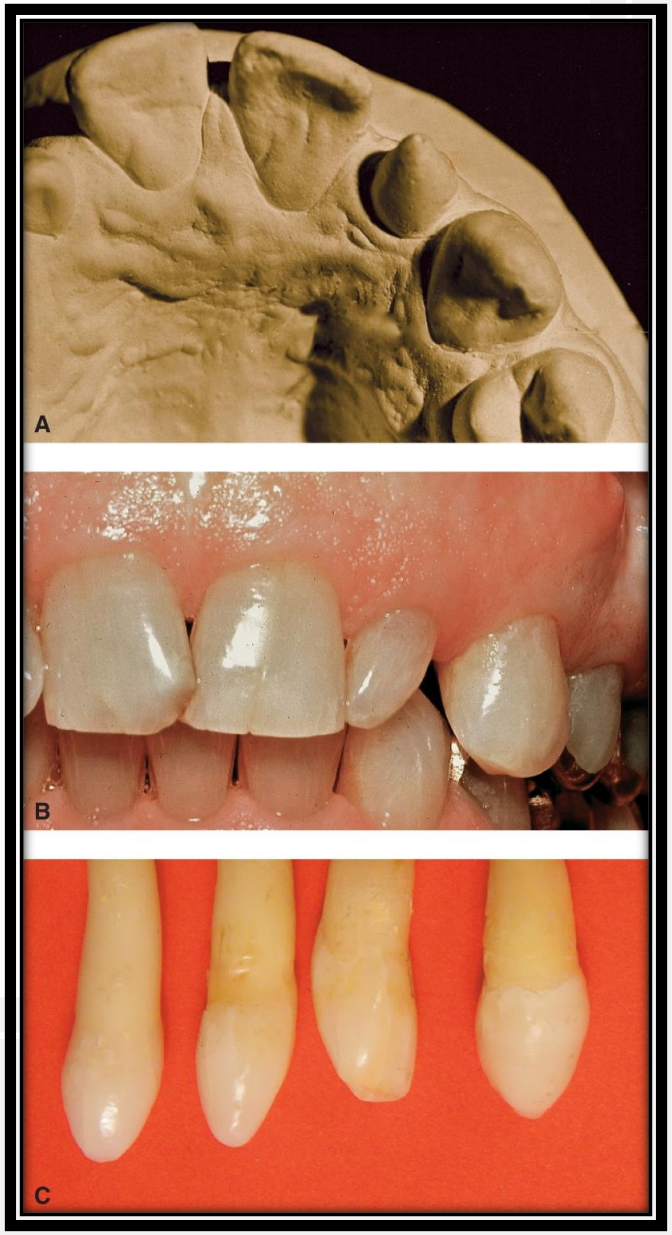


3. SHOVEL-SHAPED TEETH

- On incisors only
- lingual surfaces are scooped as a consequence of lingual marginal ridges, crown curvature or basal tubercles,
- Either alone or in combination
- Mostly with East Asian populations

4. PEG-SHAPED TEETH

- A cone shaped look
- Dental disorder called microdontia, a condition where one or more teeth appear smaller than average
- Upper lateral incisors or 3rd molars are the most common teeth affected
- Have shorter roots than usual teeth
- On both sides in most instances



5. ENAMEL PEARLS

a small nodule of dentine with an enamel cap on the root surface

may be an entirely separate nodule, or be joined to the crown at the cervix by a narrow strip of enamel

STUDY CASE

Bioarchaeology of the Near East, 15:1–24 (2021)

The people of Avaris: Intra-regional biodistance analysis using dental non-metric traits

Nina Maaranen*[1], Sonia Zakrzewski[2], Arwa Kharobi[1], Chris Stantis[1,3], Silvia Prell[4], Manfred Bietak[4], Holger Schutkowski[1]

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STUDY CASE:
AIM, MATERIALS & METHOD

Dental non-metric traits recorded from 90 individuals

Both intra- & inter-site analyses were conducted

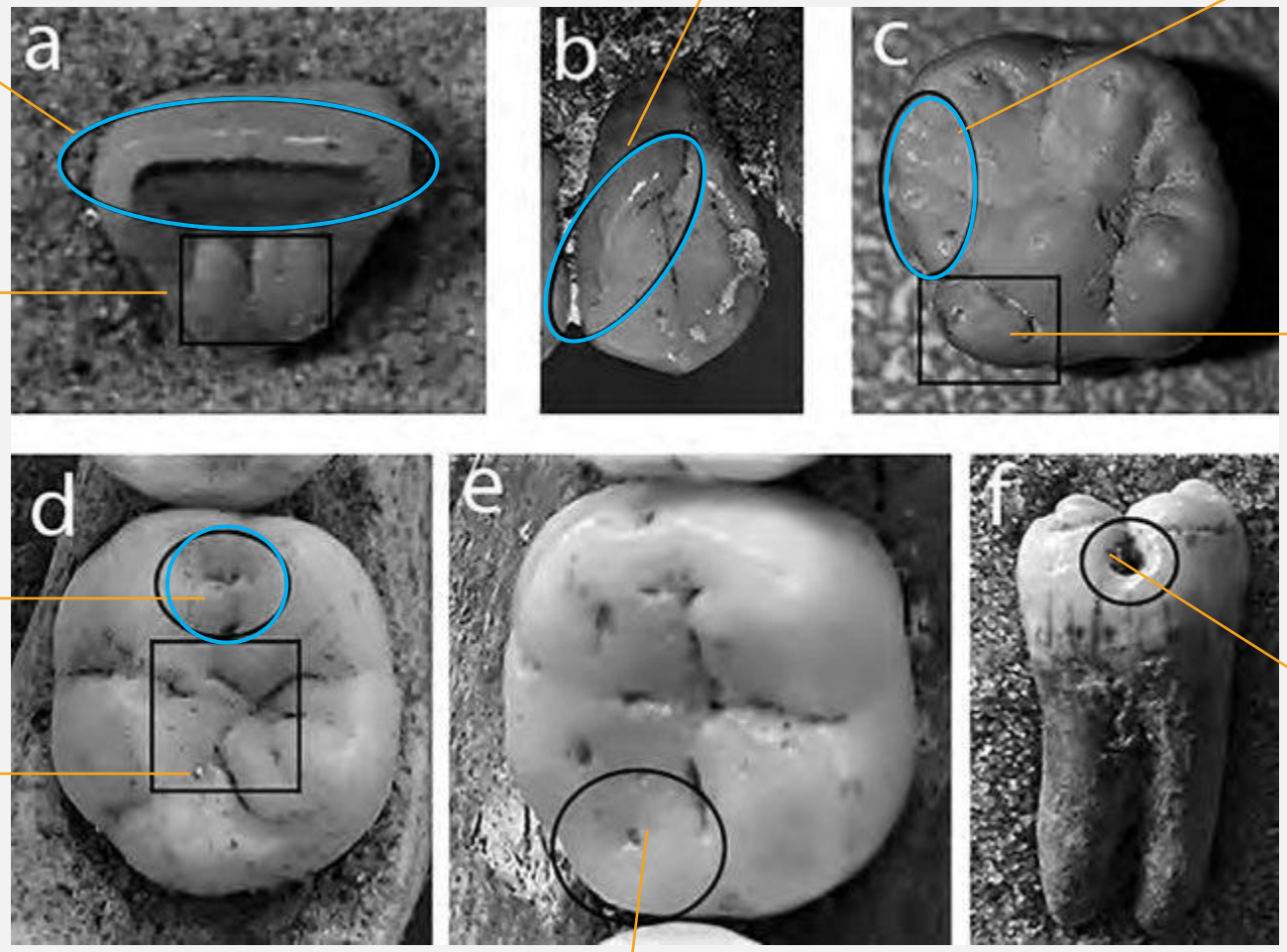
Compare ancestry between:

- locals & non-locals at Avaris
- Avaris to other Egyptian sites to gauge its population distinctiveness

- List of ASUDAS dental traits

Trait	Recorded	Abbreviation
Winging	Score	W
Labial curvature	Score	LC
Palatine torus	Score	PT
Shoveling	Score	S
Double-shoveling	Score	DS
Interruption groove	Present/Absent	IG
Tuberculum dentale	Score	TD
Pegged of reduced incisor	Score	UI2V
Mesial accessory ridge	Score	MAR
Distal accessory ridge	Score	DAR
Premolar accessory ridges	Score	PAR
Accessory cusps	Present/Absent	AC
Metacone size	Score	M
Hypocone size	Score	H
Bifurcated hypocone	Present/Absent	BH
Cusp 5	Score	C5_UM
Marginal ridge tubercles	Present/Absent	MRT
Carabelli cusp	Score	CC
Parastyle	Score	PA
Enamel extensions	Score	EE
Upper premolar root number	Count	RN_UP
Upper molar root number	Count	RN_UM
Congenital absence	Present/Absent	M3V
Odotome	Present/Absent	O
Tome's root	Score	TR
Lower premolar lingual cusp number	Count	CN
Anterior fovea	Score	AF
Mandibular torus	Score	MT
Groove pattern	x/y/+	GP
Rocker jaw	Score	RJ
Cusp number	Score	C5_LM
Cusp number	Score	C6
Cusp 7 size	Score	C7
Deflecting wrinkle	Score	DW
C1–C2 crest	Score	MDTC
Protostylid	Score	PR
Lower canine root number	Count	RN_LC
Lower molar root number	Count	RN_LM1 or LM2
Torsomolar angle	Present/Absent	TA_LM3
Mandibular molar pit tubercle	Score	MPT

Examples of dental traits observed from the samples



shoveling

mesial accessory ridge

marginal ridge tubercles

tuberculum dentale

Carabelli's cusp

anterior fovea

Y-groove pattern

protostylid

worn but still visible cusp 5

Image created by Nina Maaranen.

STUDY CASE:
RESULTS

Avaris

Local

Non-local

not ancestrally different

significant difference ($p<0.01$)

other Egyptian sites

Results are in line with the archaeological evidence, suggesting Avaris was an important hub in the MBA eastern Mediterranean trade network, welcoming people from beyond its borders

METHODS

1. Metric dental traits
2. Non-metric dental traits
3. Ancient DNA

SEE THE TWO VIDEOS BY DR RIVOLLAT

- 1. DNA methods
- 2. DNA ancestry

PART II
MIGRATION, MOBILITY, MOUVEMENT?

INTRODUCTION

A basic distinction in evaluating human movement is scale, or time and distance travelled.

Many archaeologists differentiate between past practices of mobility & migration based on scope of movement:

Migration: a one-way, long-term or permanent relocation of one or more persons following travel across real or perceived political, environmental, or cultural borders

(Cabana and Clark 2011; Tsuda et al. 2015)

Mobility: involves individual or group movement across shorter distances that typically takes place within one's own cultural and/or political boundaries

(Tsuda et al. 2015)

Introduction

last decade:

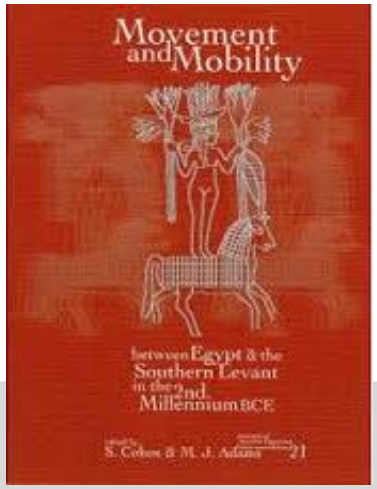
increase in migration studies focusing on the mobility of:

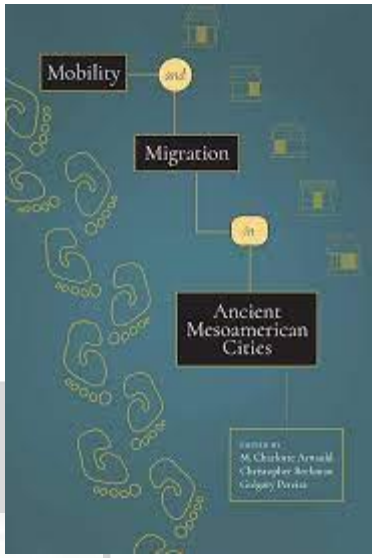
- groups
- single individuals

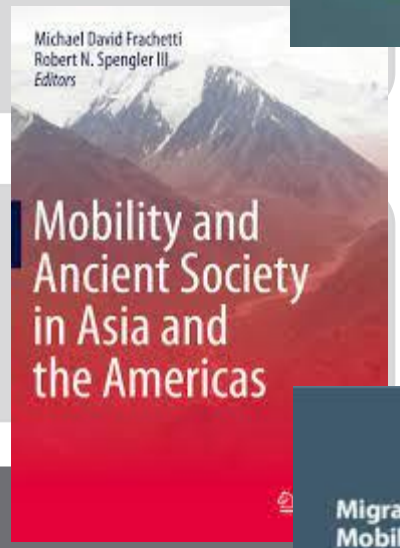
mostly based on:

- aDNA
- Strontium isotope analyses

provided important extra layer of data on past social dynamics







Introduction

current large quantity of data +

constant increase = opportunity to examine human mobility in unprecedented detail

academic dialogue is changing

from producing evidence for movement **to** examining differences or similarities in human mobilities across temporal & geographical barriers

Advantages of teeth

- Unlike bones, which regenerate through our lives,
- Teeth **do not produce new cells** when they form

forms & sets during infancy,

chemically "recording" a baby's diet

1st Molar

contains a diary of what an adult eats, and where their food originates

wisdom tooth

provide us with a map of where a person lived, between birth and burial

A mouthful of teeth

Dental calculus

Mineralized dental plaque or calculus

Tiny layers of food & bacteria

Contains 25 times more DNA than a bone

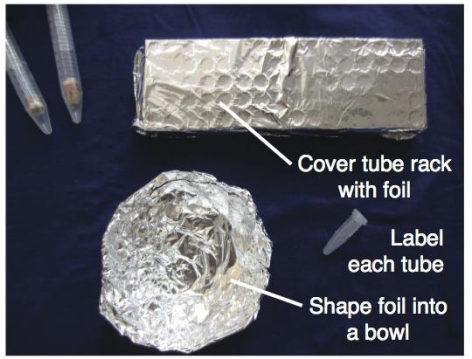
Anthropologists suggest that *researching dental calculus could unearth answers to the riddles of past migratory patterns.*

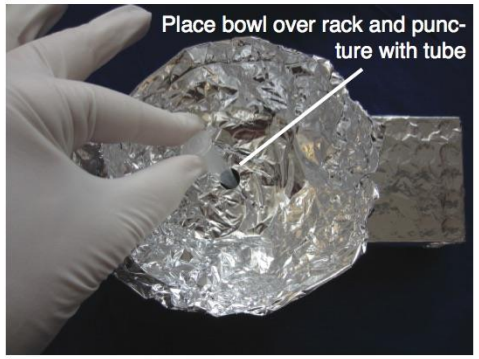
MAX-PLANCK-GESELLSCHAFT

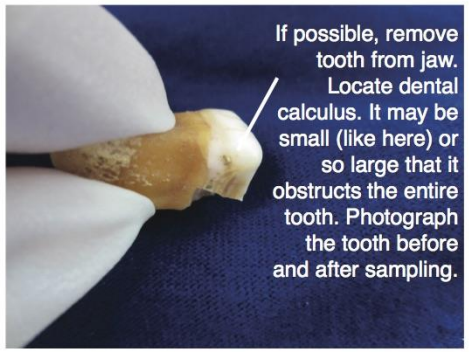
Dental Calculus

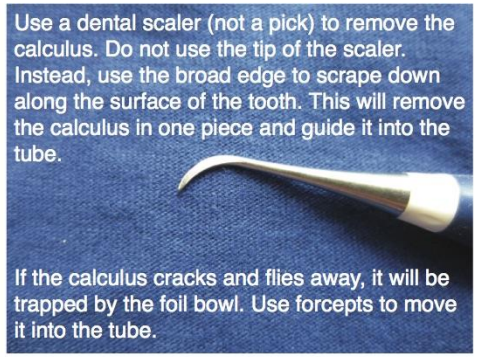
Sampling Protocol v.4, Nov. 29, 2016

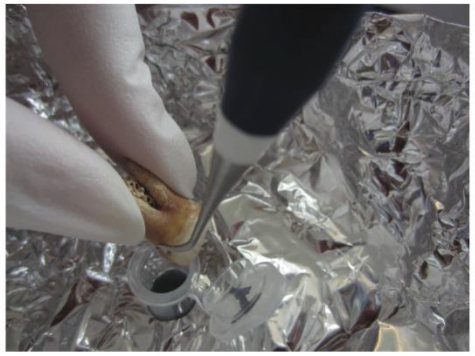
Christina Warinner, Max Planck Institute for the Science of Human History





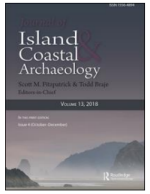






Additional Information: All dental calculus from one individual can be placed in the same tube. Use fresh foil for each individual and sterilize the scaler with an alcohol wipe between each individual. Also, change gloves or clean with alcohol wipes between individuals.

In 2019, researchers from the University of Adelaide, Australia, used calculus from the teeth of ancient Polynesians to decipher the timings and exact migration routes of prehistoric humans in the Pacific.



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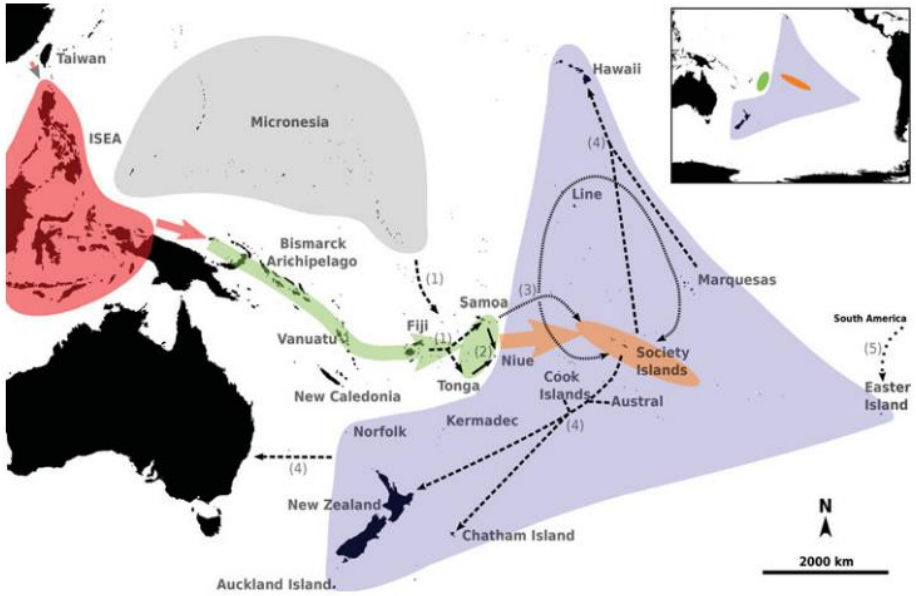
Ancient Microbial DNA in Dental Calculus: A New method for Studying Rapid Human Migration Events

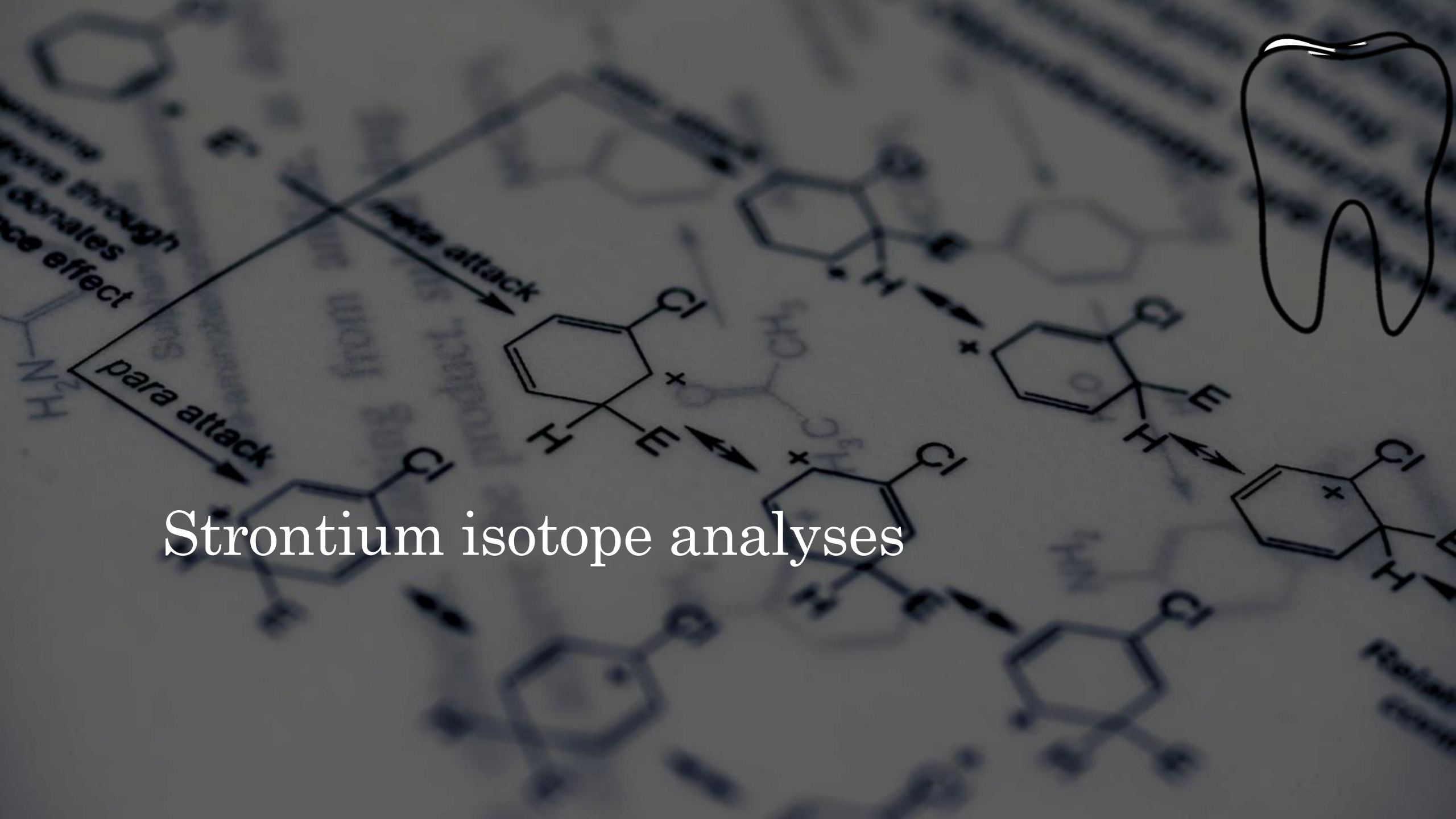
Raphael Eisenhofer, Atholl Anderson, Keith Dobney, Alan Cooper & Laura S. Weyrich

To cite this article: Raphael Eisenhofer, Atholl Anderson, Keith Dobney, Alan Cooper & Laura S. Weyrich (2019) Ancient Microbial DNA in Dental Calculus: A New method for Studying Rapid Human Migration Events, The Journal of Island and Coastal Archaeology, 14:2, 149-162, DOI: 10.1080/15564894.2017.1382620

To link to this article: https://doi.org/10.1080/15564894.2017.1382620

Raphael Eisenhofer et al.

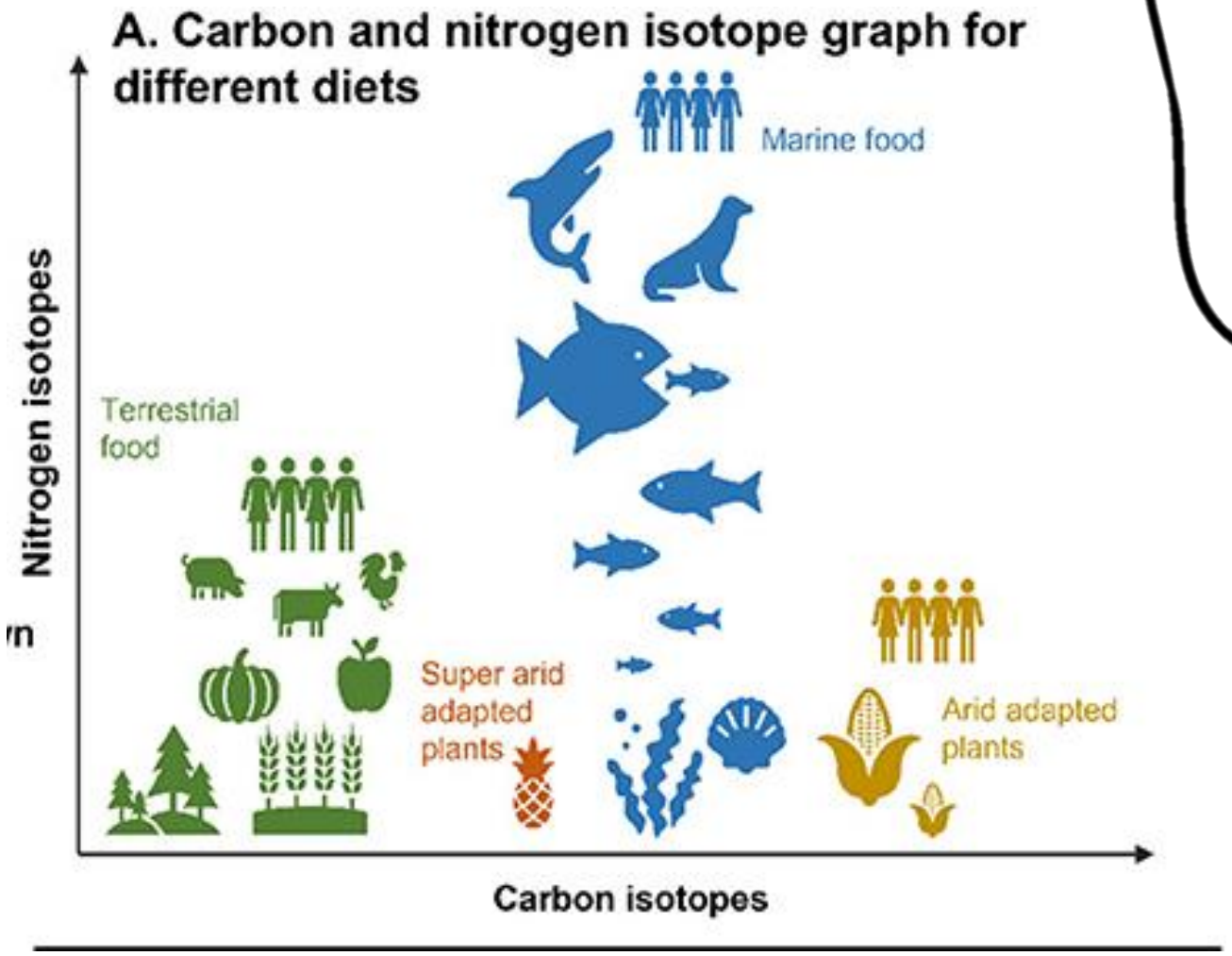




Strontium isotope analyses

For diet

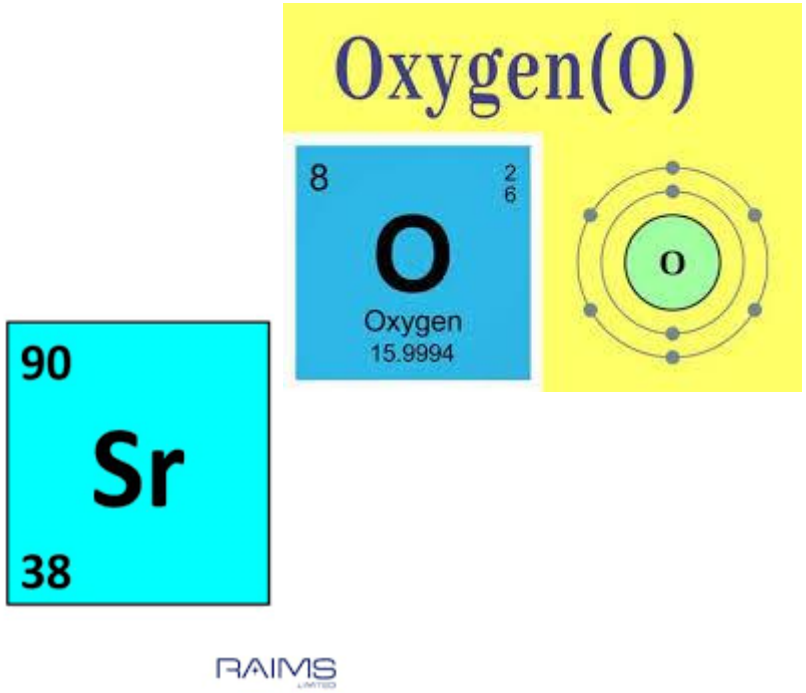
Tell me what you eat, Ill tell you who you are!

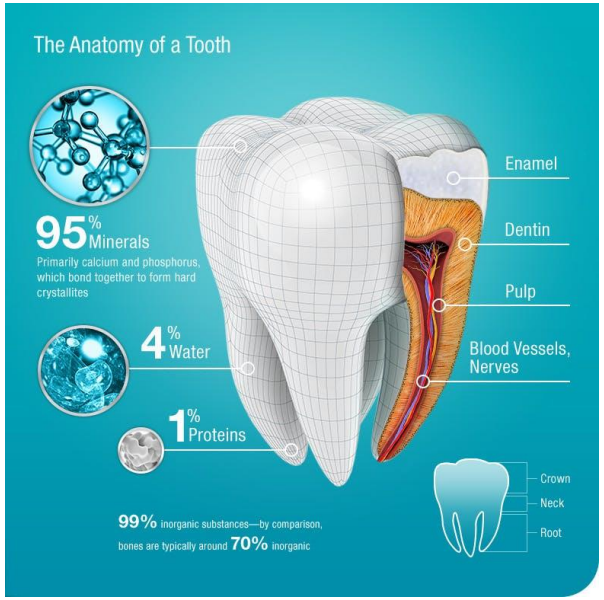


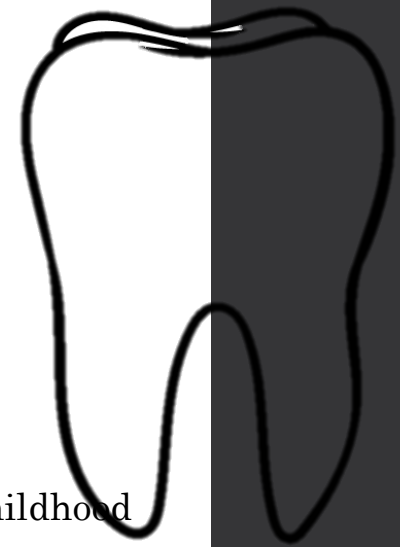
Understanding How People Moved Around From Teeth

To uncover where people were living in the past, we can use two isotope systems:

1. oxygen
2. strontium





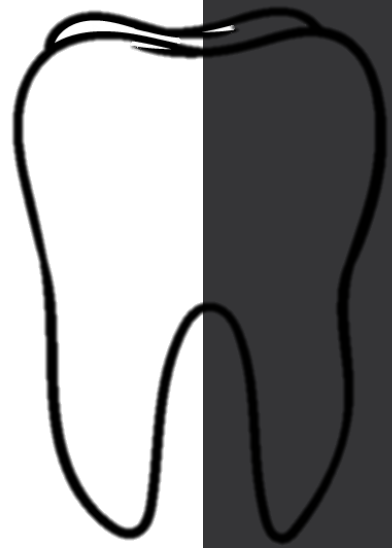


Local or not?

1. **Tooth** enamel forms during early childhood and does not change
2. **Bone** changes continually through life
3. **Difference** in Sr isotope ratio between bone & enamel in the same individual →

change in residence or not?

Understanding How People Moved Around From Teeth

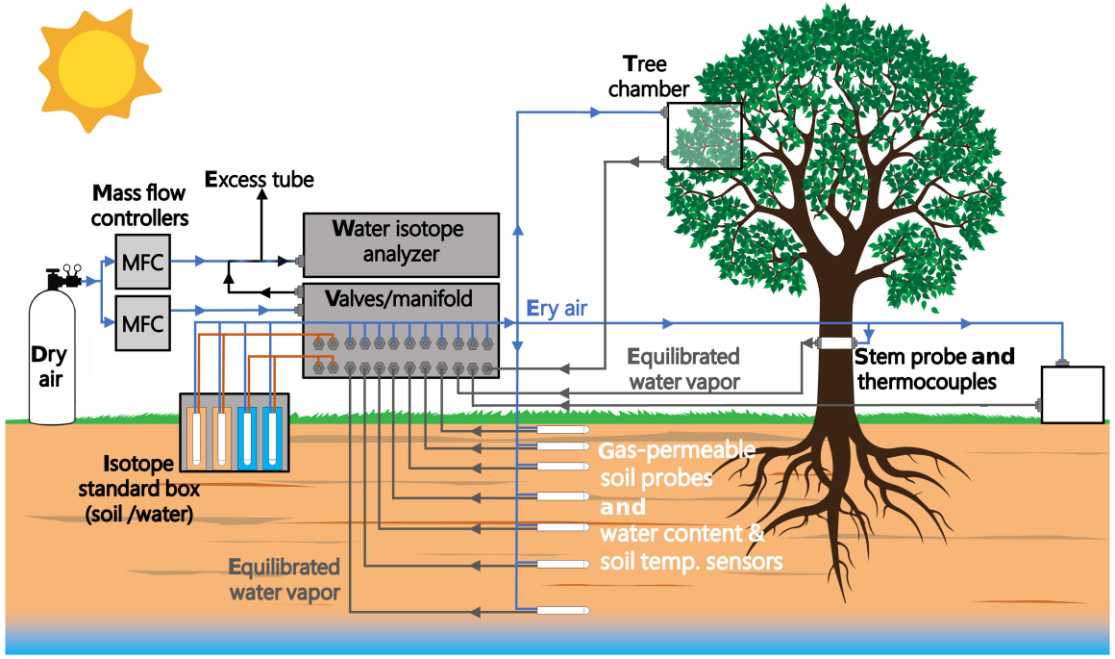


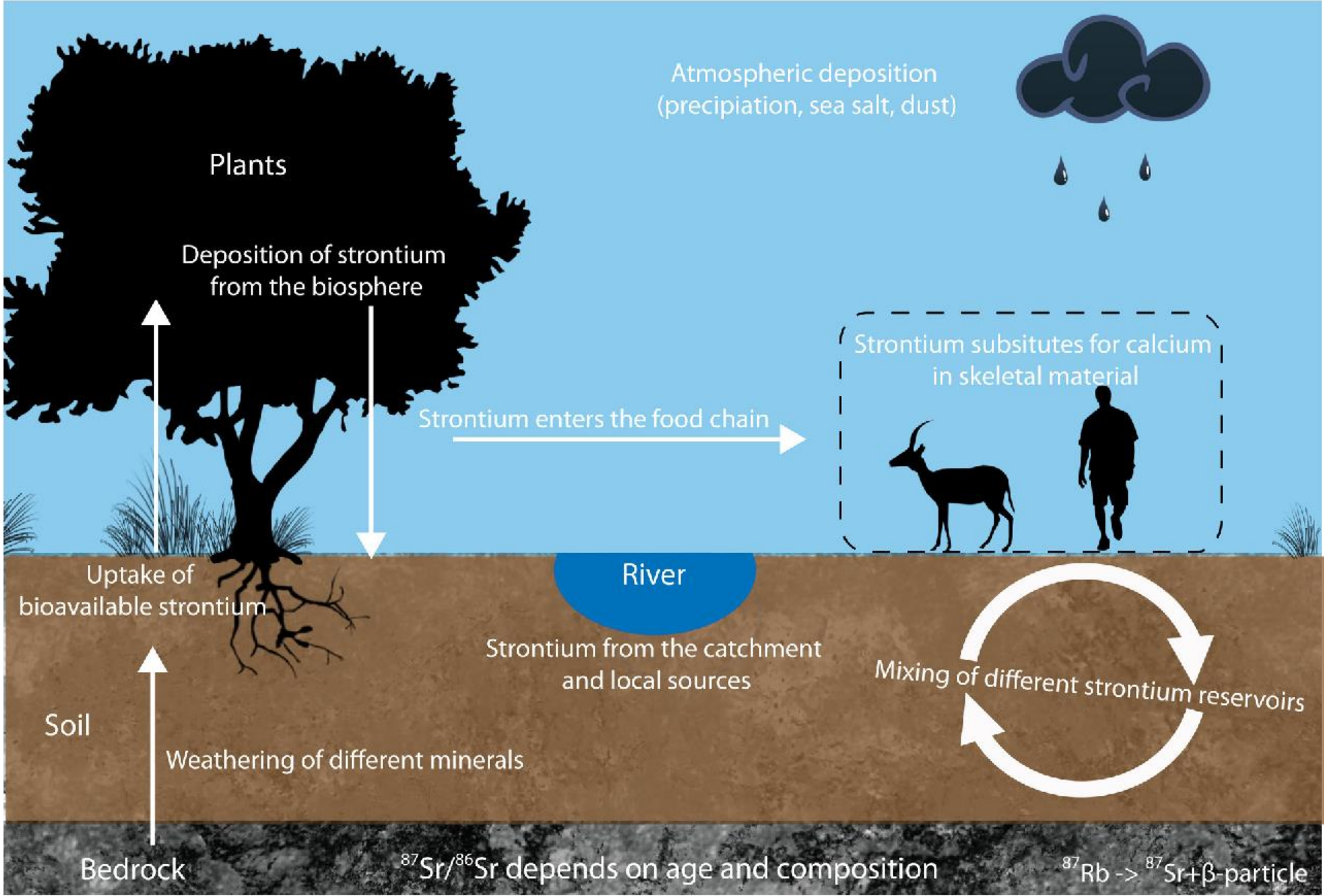
δ16O & δ18O ratios in rain change with climate

As drinking water often comes from rain, O ratios in teeth reflect the region that people were living in

87Sr & 86Sr are found in different amounts in different types and ages of bedrock

As the bedrock erodes, these isotopes get into the soil and into plants, so when humans or animals eat, the environment's Sr isotope ratio is incorporated into their teeth




Plants
Deposition of strontium
from the biosphere
Atmospheric deposition
(precipiation, sea salt, dust)
Strontium enters the food chain
Strontium subsitutes for calcium
in skeletal material
Uptake of
bioavailable strontium
River
Strontium from the catchment
and local sources
Mixing of different strontium reservoirs
Soil
Weathering of different minerals
Bedrock
$^{87}Sr/^{86}Sr$ depends on age and composition
^{87}Rb -> ^{87}Sr+β-particle

Understanding How People Moved Around From Teeth

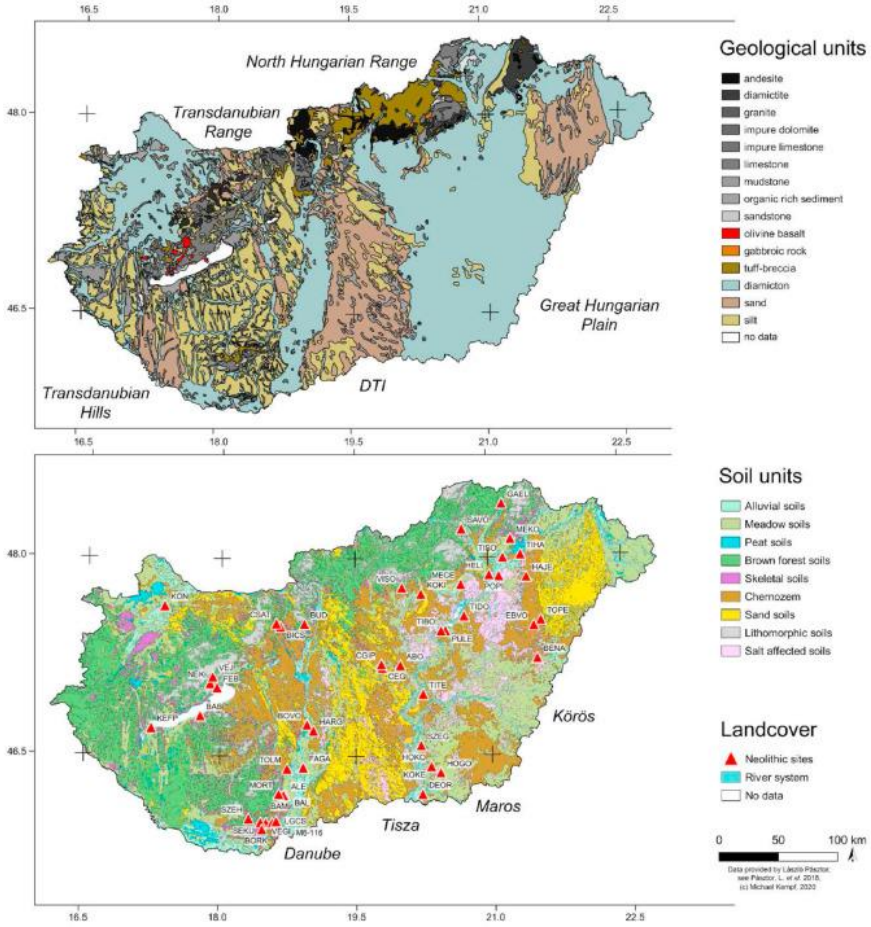
Before we can make sense of the O or Sr isotope ratios measured in a human tooth

we need to understand how these isotope ratios vary in a region

measure the isotopes in

1. soils
2. plants
3. water
4. animals

to create a baseline map

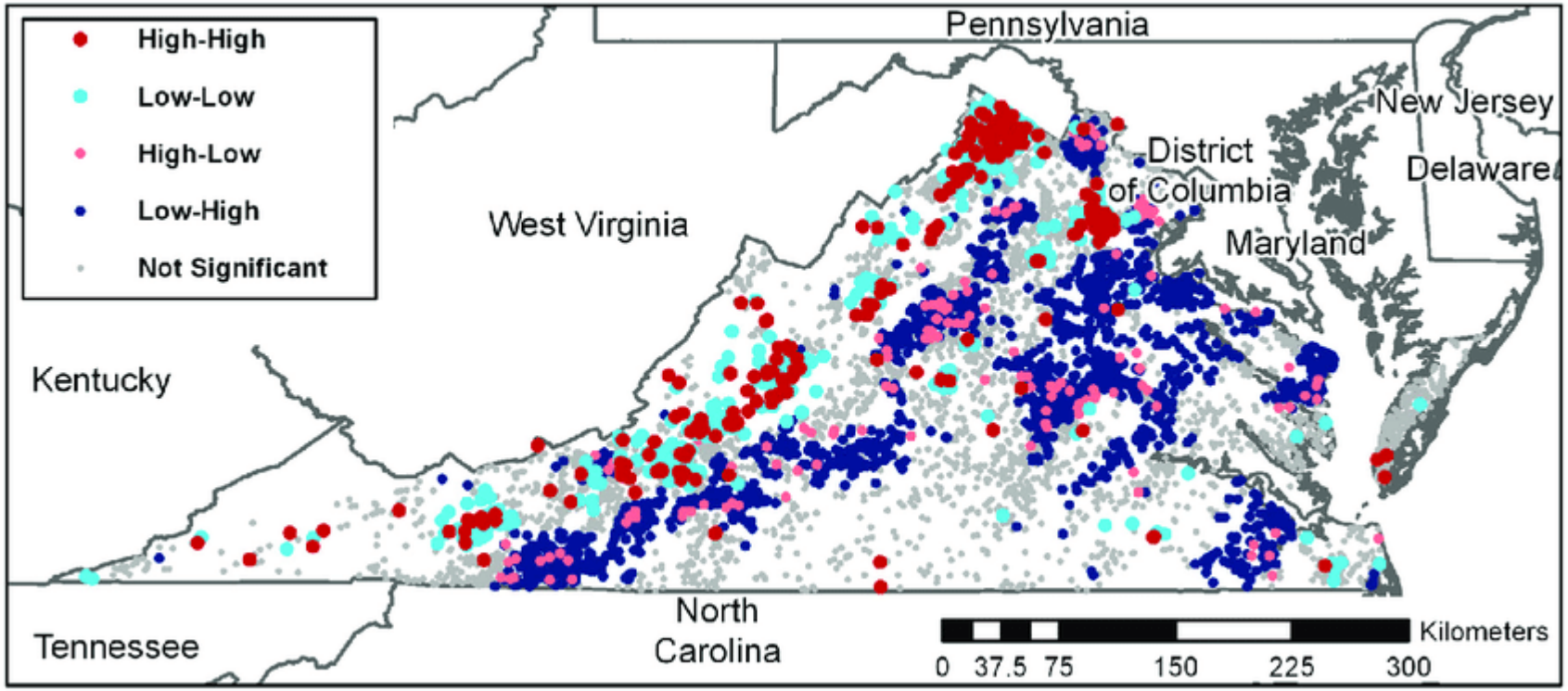


A baseline map

shows how O & Sr isotopes vary across landscape

we can then compare isotope ratio in teeth to these maps

Local vs non-local

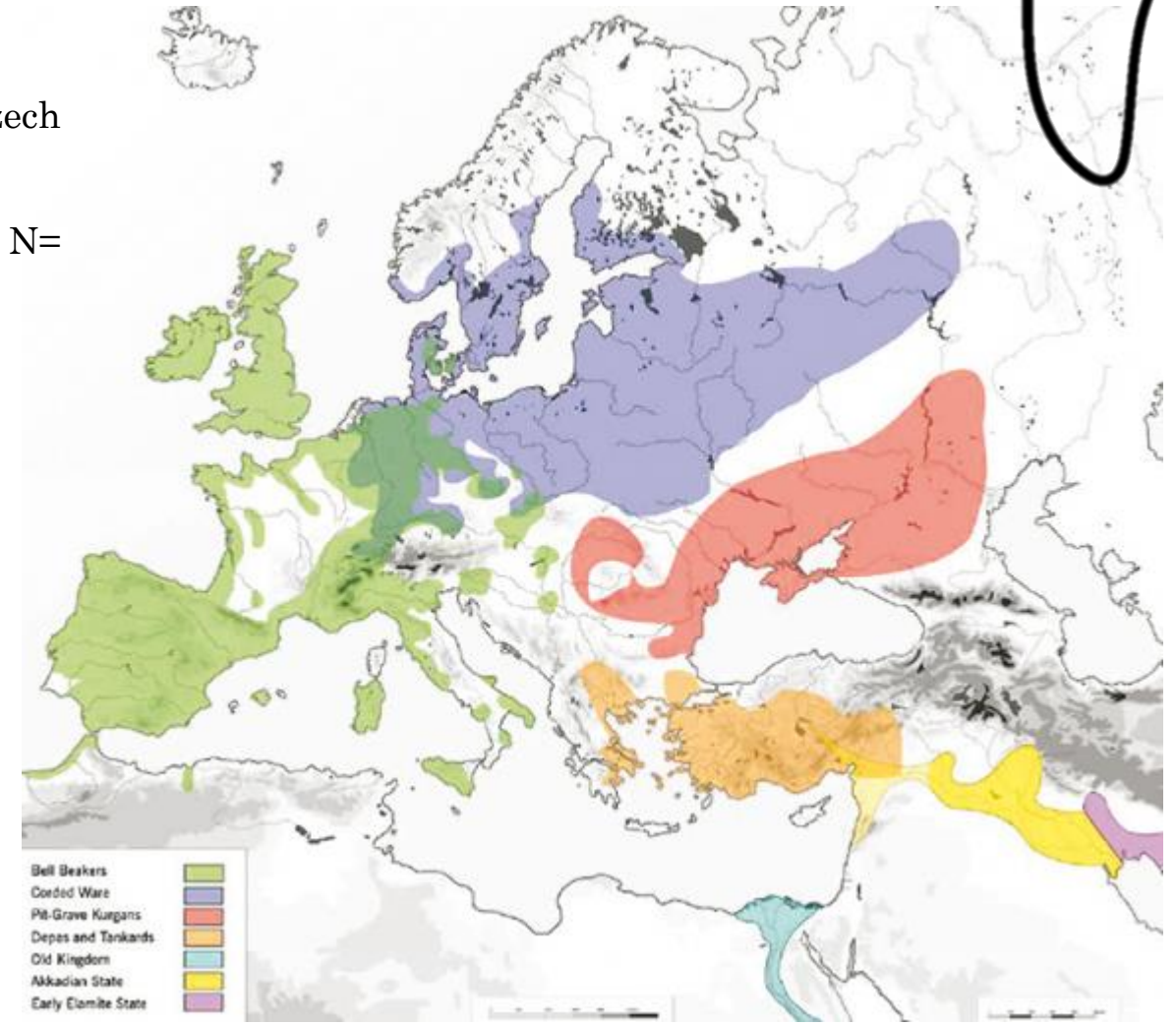


Sr & Prehistoric Human Migration:
The Bell Beaker Period in Central Europe

Context: southern Germany, Austria, Czech Republic, & Hungary

M & M: Sr isotope ratios in bone & tooth enamel, N= 81

Results: 51 had moved during their lifetime



2017

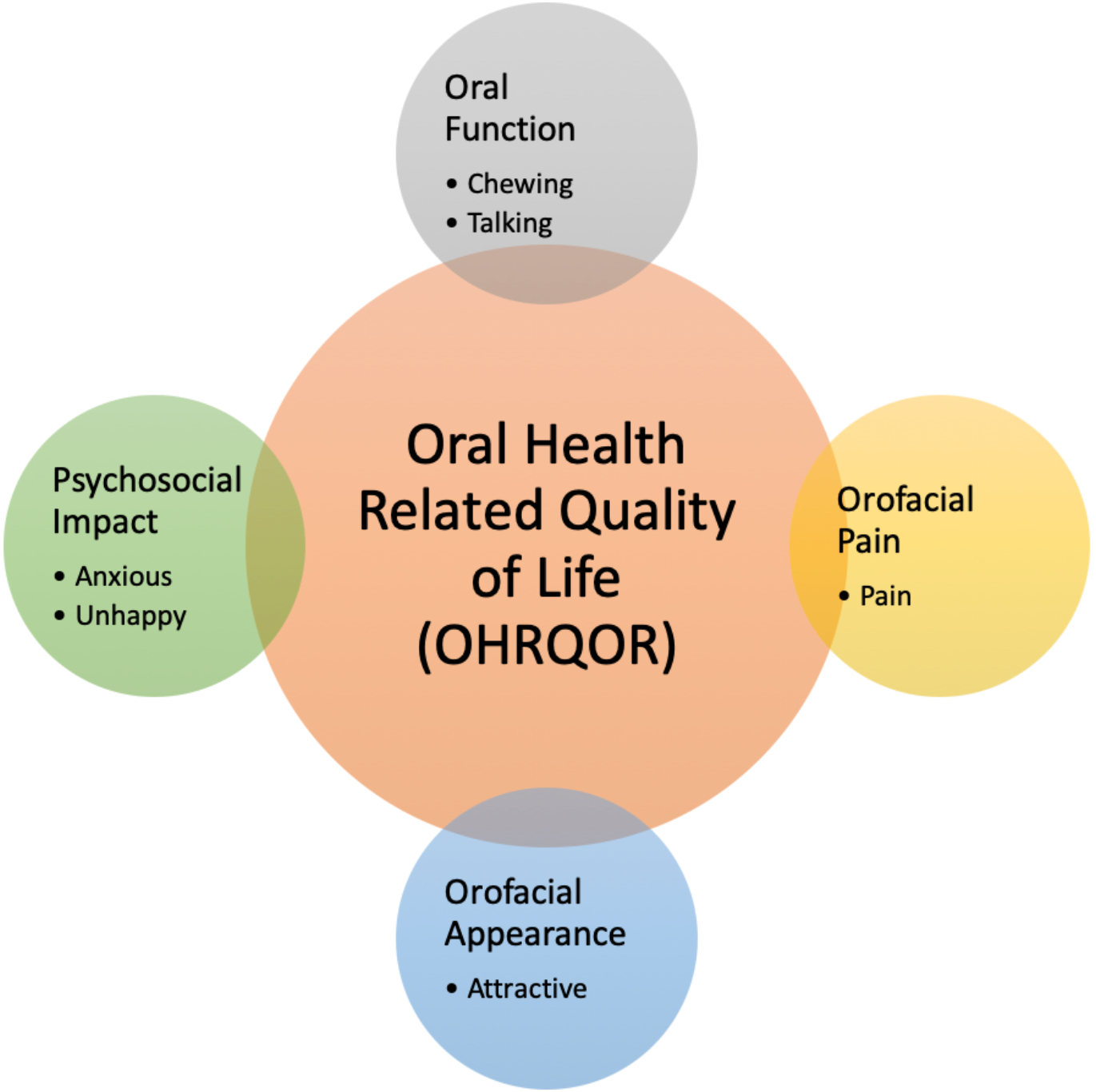
Association between migration & oral health-related quality of life:

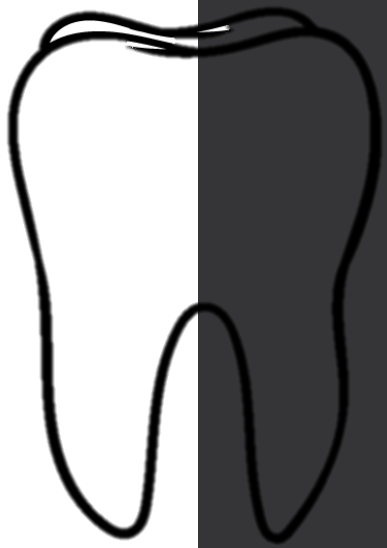
Aarabi et al. 2022

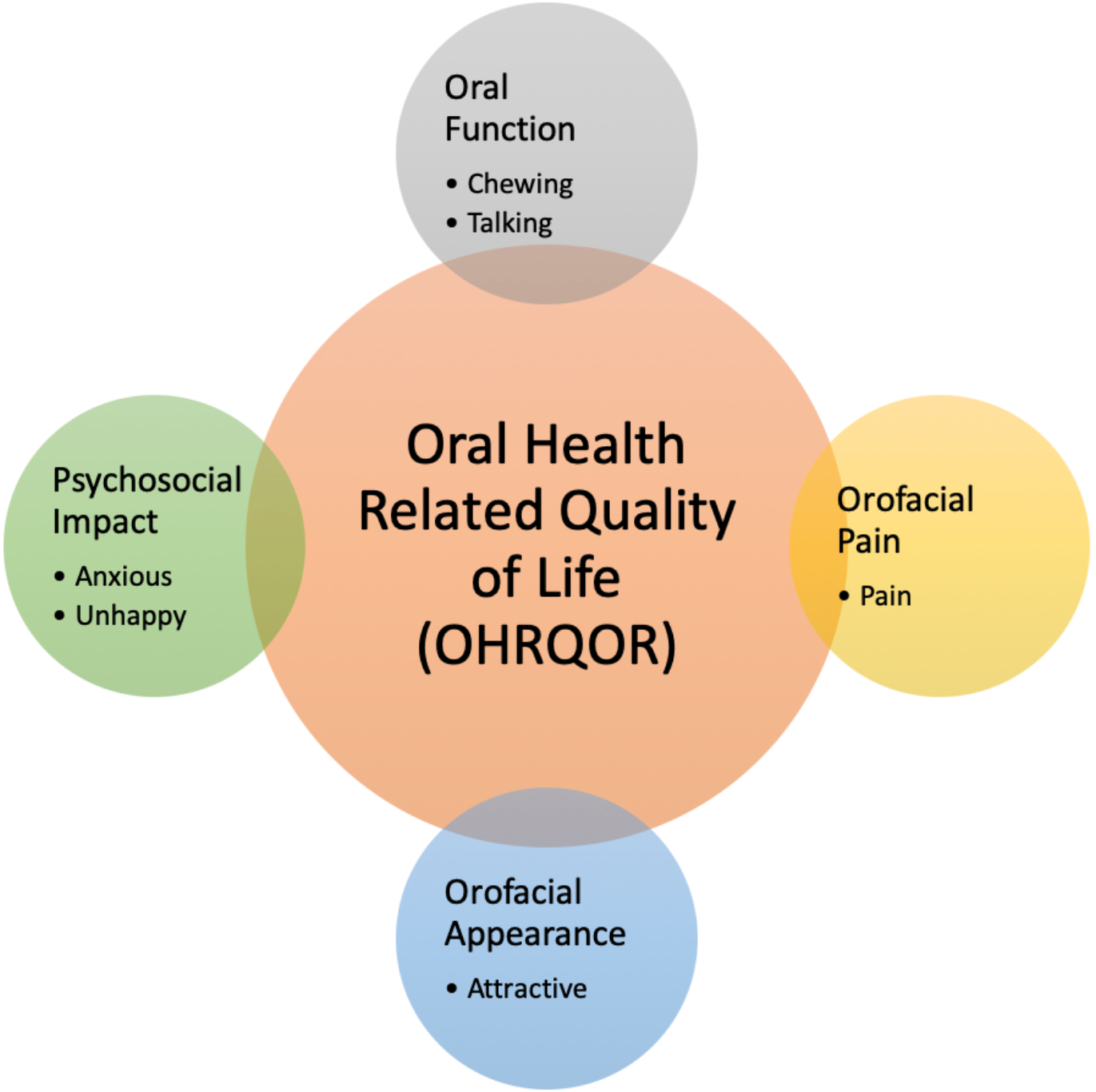
Data taken from a nationally representative online survey

- ✓ (n = 3,075; 18–70 years; living in Germany)
- ✓ from August to September 2021

Purpose: To analyze the link between individuals with and without migration background and oral health-related quality of life (also stratified by sex).


Oral Function
• Chewing
• Talking
Psychosocial Impact
• Anxious
• Unhappy
Oral Health Related Quality of Life (OHRQOR)
Orofacial Pain
• Pain
Orofacial Appearance
• Attractive

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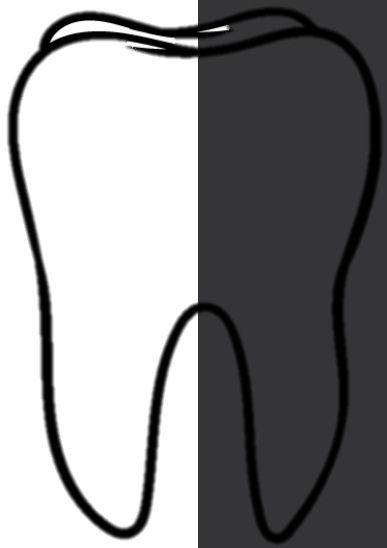


Protocol

1. Have you had difficulty chewing any foods because of problems with your teeth, mouth, dentures or jaw?
2. Have you felt that there has been less flavor in your food because of problems with your teeth, mouth, dentures or jaws?
3. Have you had painful aching in your mouth?
4. Have you felt uncomfortable about the appearance of your teeth, mouth dentures or jaws?
5. Have you had difficulty doing your usual jobs because of problems with your teeth, mouth, dentures or jaws?

(in each case: 0-never, 1-hardly ever, 2-occasionally, 3-fairly often, and 4-very often)

A sum score was computed.

Thus, the OHIP-G5 ranges from 0 to 20 (higher scores reflect lower oral health-related quality of life).

Cronbach's alpha was 0.85 in our current study.

Independent variables

The key independent variable was self-rated migration background

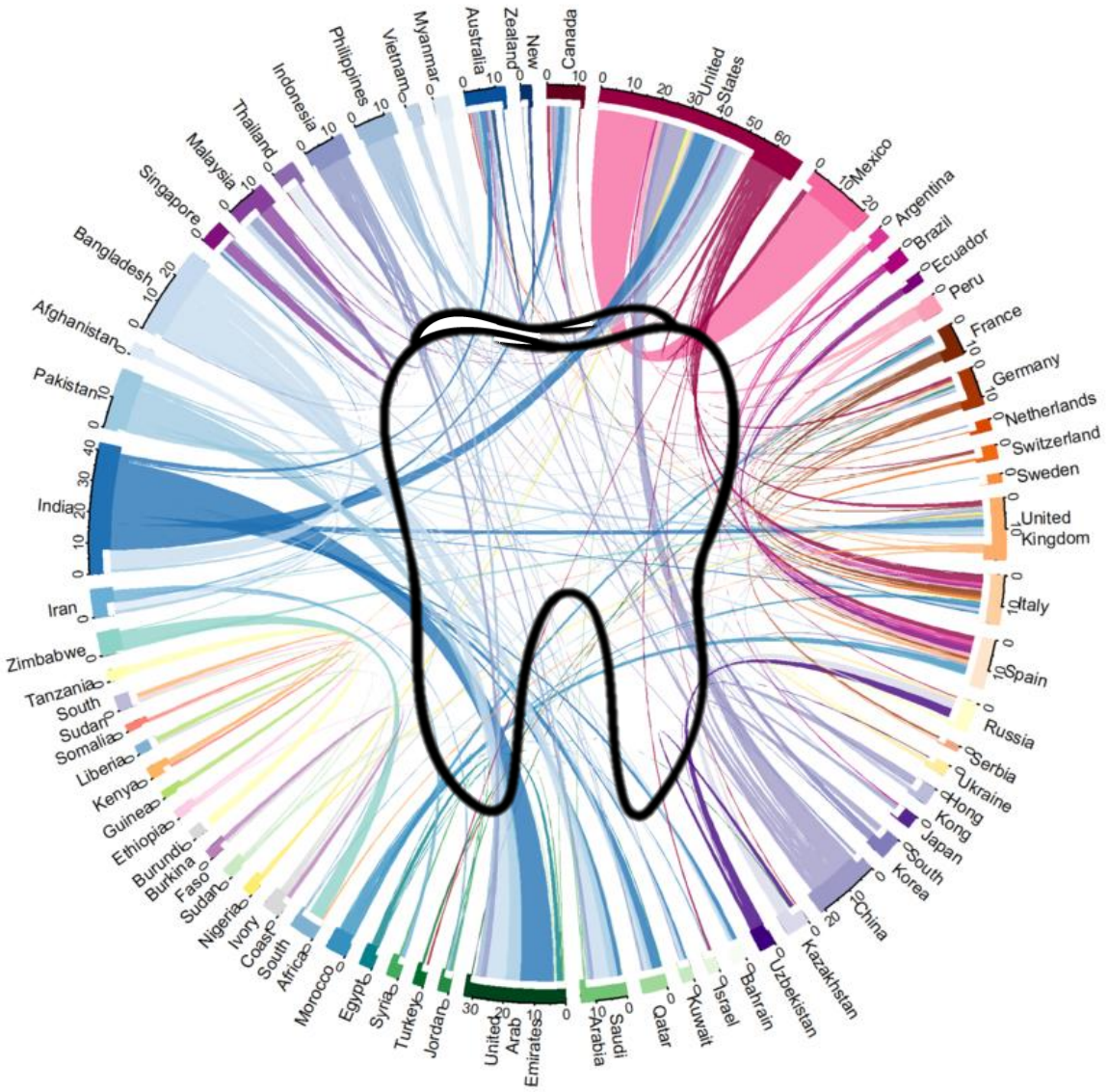
- no
- yes

explained as follows

“A person has a migration background if he or she or at least one parent was not born with German citizenship”.

Results

- ✓ Small (women) to medium (men) differences in oral health-related quality of life (in terms of effect size) between individuals with migration background and their counterparts.
- ✓ Two-part models revealed that the migration background was associated with a higher likelihood of OHIP-G5 scores of one or higher total sample and in both sexes.
- ✓ Migration background was positively associated with the extent of oral health-related quality of life (total sample and in men).
- ✓ Migration background was associated with lower oral health-related quality of life (total sample and in both sexes)



Conclusions

- ✓ This study emphasized the **link between having a migration background** & **lower oral health-related quality of life** among both women and men.
- ✓ Maintaining oral health among individuals with a migration background is a **key challenge**.
- ✓ Culturally & socially sensitive actions should provide easy accessible oral health information & preventive measures in order to lower access barriers in dental care for individuals with migration background

Conclusions on oral health, teeth & mouvements

1. Local vs nonlocal
2. Movements trajectory
3. links between oral health and cultural, social & geographical background
4. Identity (forensic and archaeological) contexts

Today, forensic scientists apply techniques of isotopes (diet/migration) to identify people who die during perilous journeys…..

"It's a bit harder, since modern people eat food from so many different places, but if our combined work in this area can bring a person home to their family, it's worth the effort."


Thank you!