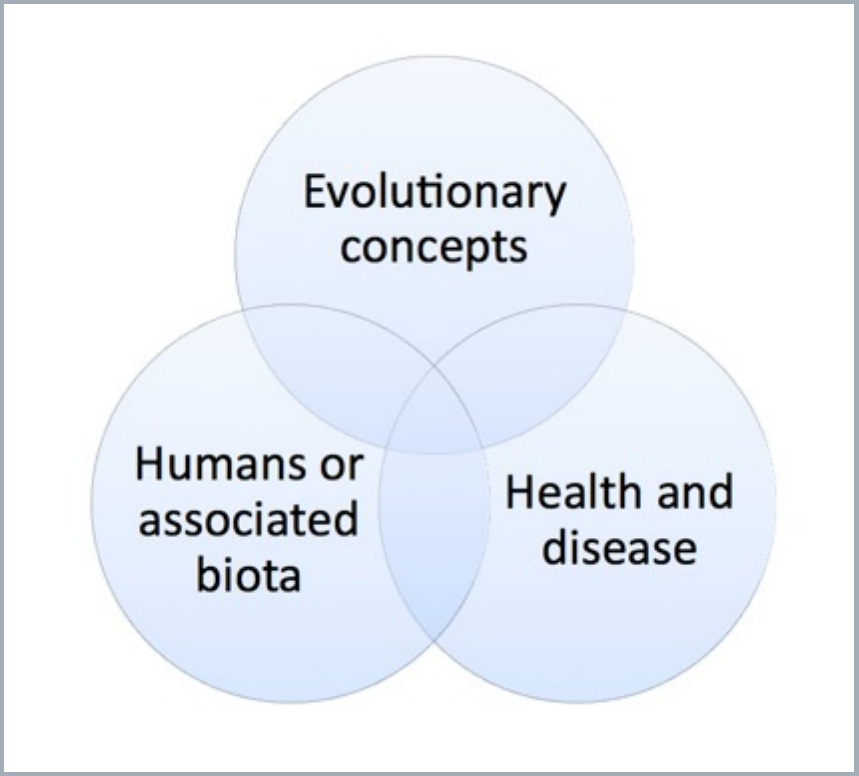
Evolutionary Medicine: A scientific look at our past, present… and future?

Frank Rühli and Team

Introduction



Alcook, J Evol Med, 2012

Evolutionary Medicine: "*Why?*" not only "*How?*"

- Evolutionary medicine or Darwinian medicine investigates **human disease vulnerability and disease aetiologies** (genetics, behaviour, environment, pathogens etc.) from an evolutionary perspective

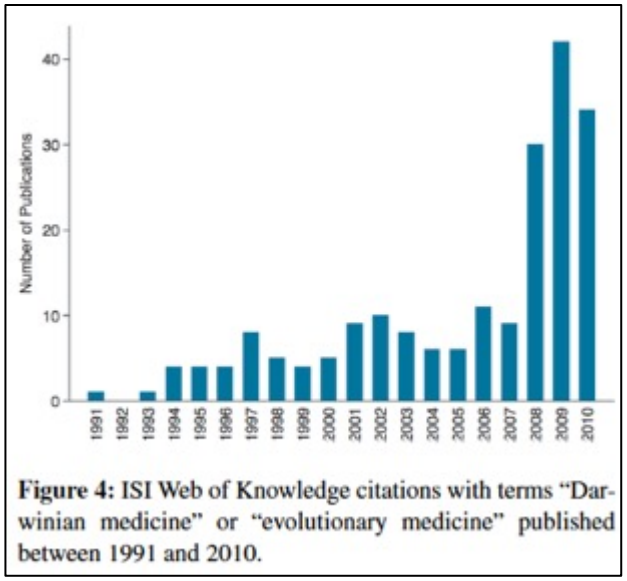


Figure 4: ISI Web of Knowledge citations with terms "Darwinian medicine" or "evolutionary medicine" published between 1991 and 2010.

Alcock, *J Evol Med*, 2012

Evolutionary Biology and Medicine

Table 1 | Topics in evolutionary biology with medical relevance

Evolutionary approach/Subfield	Medical relevance
Molecular phylogenetics and phylogenomics	Cancer metastasis, clonal dynamics and the transmission dynamics of infectious diseases
Evolutionary genetics and genomics	Population histories, genetic variation for disease resistance and drug metabolism
Life-history evolution	Maturation, menopause, aging and tradeoffs
Plasticity and reaction norms	Genotype by environment interactions that affect disease risk; developmental origins of health and disease
Rapid evolution of resistance	Antimicrobial and cancer treatments
Reproductive biology	Placentation, pregnancy disorders and infertility
Genomic conflicts	Parent-of-origin imprinting, nuclear–cytoplasmic conflicts, meiotic drive, selfish genetic elements

Stearns, *Nat Ecol Evol*, 2017

University of Zurich[UZH]

Institute of Evolutionary Medicine (IEM)

Mummy Studies

Mumienforschung: 4. Dimension der Medizin

- Der Wert historischer Proben für die Untersuchung der Evolution humaner Morphologie und Krankheiten wird mehr und mehr akzeptiert (Bosch, Lancet, 2000)
- Der Mensch ist des Menschen bestes Archiv. Gewebe ist besser als wenn „nur“ historische Quellen vorliegen.
- Mumien sind besonders: Erhaltung von Weichteilen erlaubt mehr medizinische Informationen
- Holistische Forschung
- Reflexion über eigene Sterblichkeit

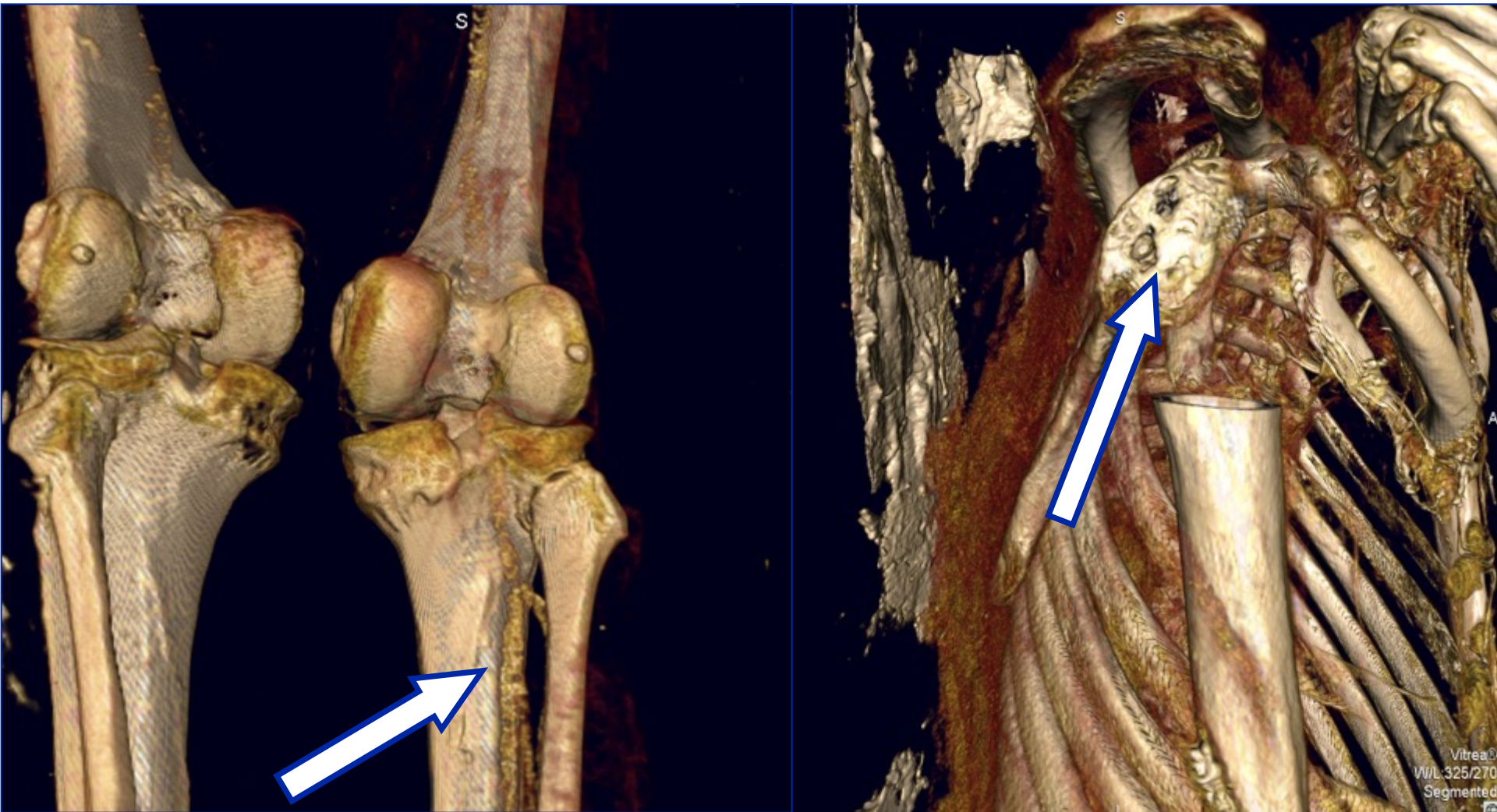
Pharao Sethos I.
(ca. 1300 v. Chr.; Smith, Royal Mummies, 1912)

Paleopathology and Mummy Studies Group

- MD's, Egyptologists, dentists, anthropologists, molecular biolgists, …
- Egyptian / Roman-Greek / Peruvian / Medieval / Salt Mummies / Ice Mummies, …
- Collections in Switzerland, Germany, Italy, France, USA, Australia, …
- Field work in Egypt, Iran, Botswana, Sudan …

DFG Deutsche Forschungsgemeinschaft
the cogito foundation
FNSNF Fonds National Suisse Schweizerischer Nationalfonds Fondo Nazionale Svizzero Swiss National Science Foundation
Georg und Bertha Schwyzer-Winiker Stiftung
Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra
Eidgenössisches Departement des Innern EDI Bundesamt für Kultur BAK
National Geographic Society
Stiftung Mercator Schweiz
Athenaeum Stiftung
Forschungskredit UZH
Ernst Göhner Stiftung
UNESCO

Krankheiten (Kardiovaskulär, Arthrose)



- Experimental and basic mummification studies
- Feasibility of clinical and experimental diagnostic imaging modalities
- Developing of portable imaging methods
- Promoting a paleo-one-health approach
- Paleo-epidemiology of NCDs
- Clinical assessments of paleopathological cases
- Capacity Building in Egypt

Der Mann aus dem Eis
ca. 3300 v. Chr.

Was können wir von alten Pathogenen lernen?

- Identifikation der Verursacher historischer Pandemien
- Einblicke in die Langzeitevolution von Pathogenen
- Gemeinsame Vorfahren und Mutationsraten von Pathogenen

nature genetics

nature.com ▸ journal home ▸ advance online publication ▸ article ▸ abstract

ARTICLE PREVIEW

NATURE GENETICS | ARTICLE

Pathogens and host immunity in the ancient human oral cavity

Christina Warinner, João F Matias Rodrigues, Rounak Vyas, Christian Trachsel, Natallia Shved, Jonas Grossmann, Anita Radini, Y Hancock, Raul Y Tito, Sarah Fiddyment, Camilla Speller, Jessica Hendy, Sophy Charlton, Hans Ulrich Luder, Domingo C Salazar-García, Elisabeth Eppler, Roger Seiler, Lars H Hansen, José Alfredo Samaniego Castruita, Simon Barkow-Oesterreicher, Kai Yik Teoh, Christian D Kelstrup, Jesper V Olsen, Paolo Nanni, Toshihisa Kawai + *et al.*

Affiliations | Contributions | Corresponding authors

Nature Genetics (2014) | doi:10.1038/ng.2906

Received 31 May 2013 | Accepted 03 February 2014 | Published online 23 February 2014


B17


B61


B78


G12

Results

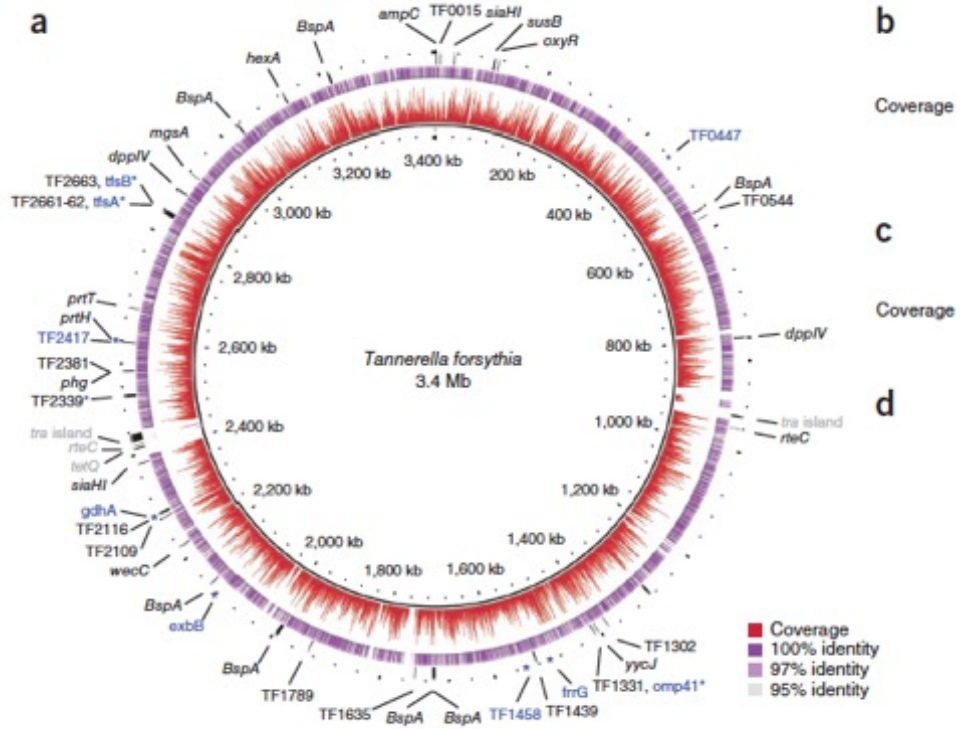


Figure 2 Genomic coverage plot for the periodontal pathogen *T. forsythia*, with details of gene a

Table 1 Putative pathogens sequences in ancient dental

Pathogens[a]
Actinomyces odontolyticus[c]
Aggregatibacter actinomycetemcomitans
Campylobacter concisus
Campylobacter curvus
Campylobacter rectus[c]
Campylobacter showae[c]
Capnocytophaga gingivalis[c]
Capnocytophaga ochracea
Capnocytophaga sputigena[c]
Clostridium difficile[d,e]
Corynebacterium matruchotii[c]
Eikenella corrodens[c]
Fusobacterium nucleatum
Fusobacterium periodonticum[c]
Gemella morbillorum[c]
Gordonibacter pamelae[d]
Haemophilus influenzae
Histophilus somni[d,f]
Leptotrichia buccalis
Neisseria gonorrhoeae
Neisseria meningitidis
Neisseria sicca[c]
Neisseria subflava[c]
Porphyromonas gingivalis
Rothia mucilaginosa
Streptobacillus moniliformis[d,f]
Streptococcus agalactiae
Streptococcus dysgalactiae[d]
Streptococcus equi[d,f]
Streptococcus gallolyticus[d,f]
Streptococcus gordonii
Streptococcus mitis
Streptococcus mutans
Streptococcus pneumoniae
Streptococcus pyogenes
Streptococcus sanguinis
Streptococcus suis[d,f]
Tannerella forsythia
Treponema denticola
Veillonella parvula

Artificial Natron: Modeling the saline deposits of Wadi El Natrun

Chemical Compund	NaCl	Na_2SO_4	Na_2CO_3	$NaHCO_3$
Fraction in %	54	16	18	12
Amount in kg	75.6	22.4	25.2	16.8

University of Zurich[UZH]

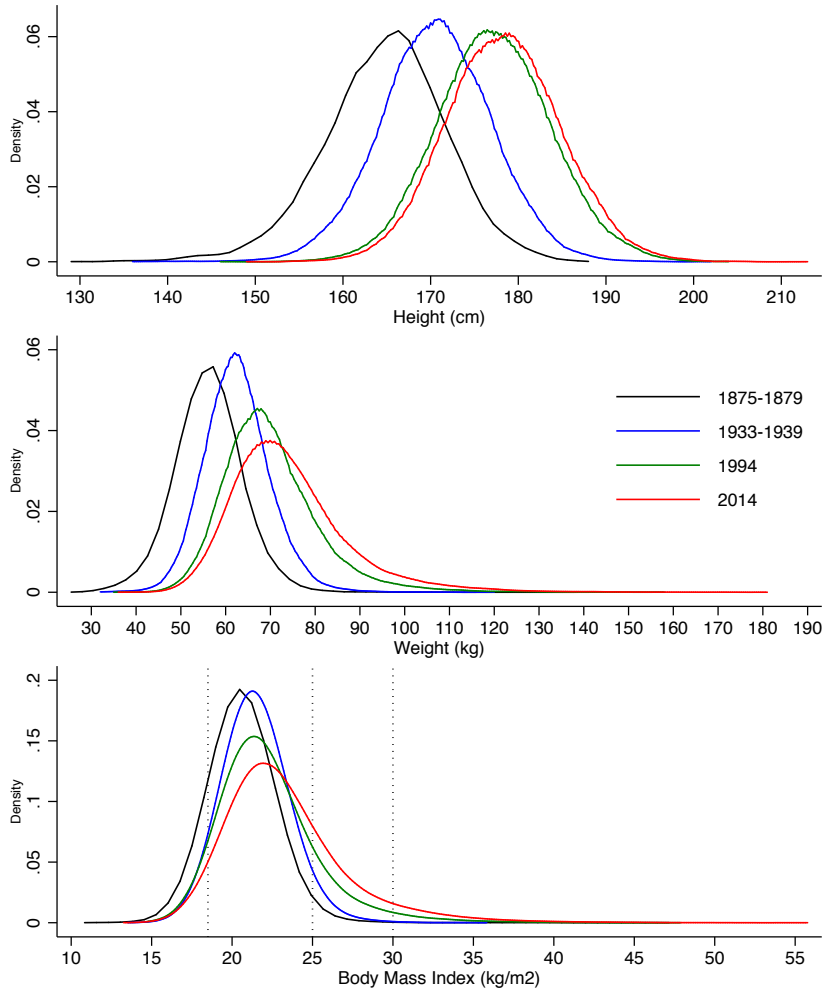
Institute of Evolutionary Medicine (IEM)

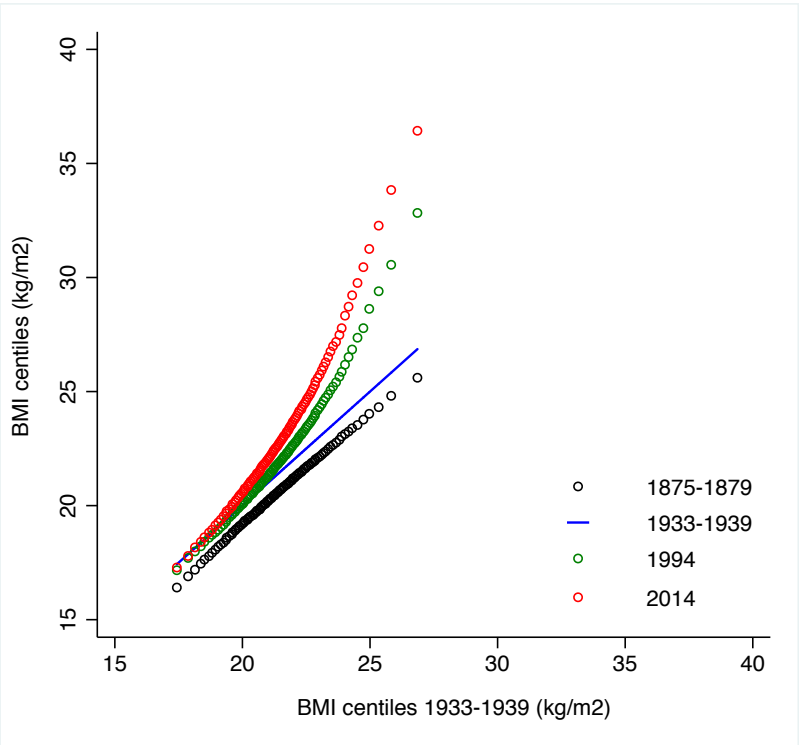
Microevolution of the human body

Changes in body morphology

- Such significant **changes in morphological characteristics** include:
  - Decrease in gastro-intestinal size (Aiello/Wheeler, Current Anthropology, 1995)
  - Decrease in body robustness, weight and height (Katzmarzyk/Leonard, AJPA, 1998)
  - Microcranialisation, brachycephalisation (Henneberg et al. 1979)
  - Reductions in the size and number of teeth (Brace et al., Evolution, 1987)
- Have occurred **since the time major civilizations developed**.
- Alterations are likely to be at least **partially the result of structural reductions** (response to lowered demands for physical strength and extra-oral food preparation).

Temporal changes in height, weight and BMI





Changes in position and shape of the height, weight and BMI distributions of 18-20y old conscripts 1875-79, 1930s, 1994 and 2014

University of Zurich[UZH]

Institute of Evolutionary Medicine

- We are part of the worldwide NCD-RisC mega-consortium (ca. 1'000 co-authors, led by Imperial College London)

A global perspective

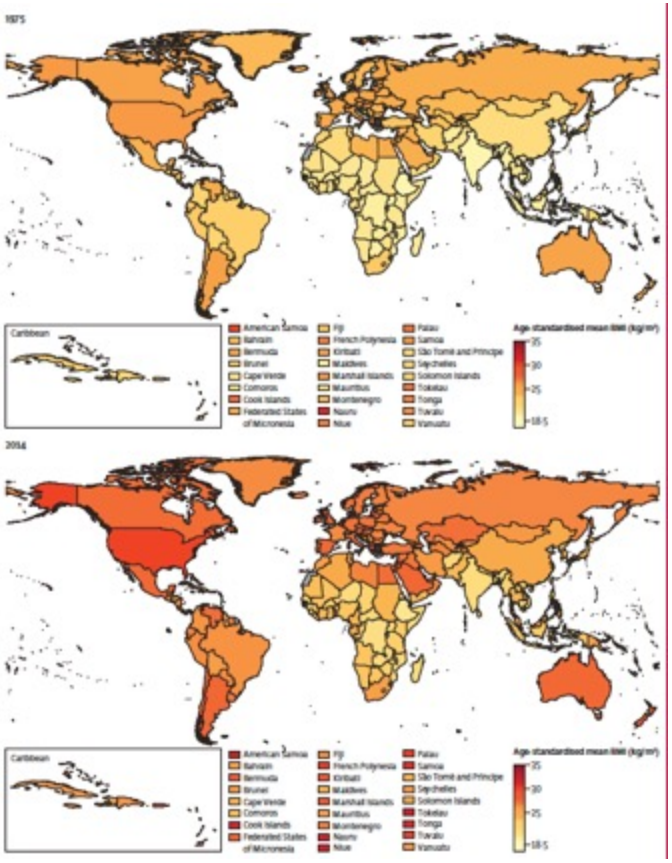
Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants

NCD Risk Factor Collaboration (NCD-RisC)*

Summary

Background Underweight and severe and morbid obesity are associated with highly elevated risks of adverse health

Lancet 2016; 387: 1377–96



Rising rural body-mass index is the main driver of the global obesity epidemic in adults

NCD Risk Factor Collaboration (NCD-RisC)*

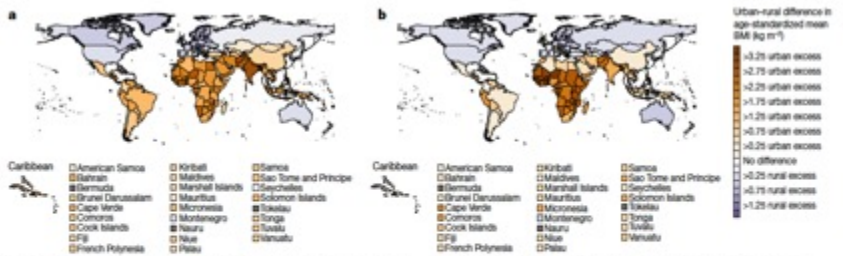


Fig. 1 | The difference between rural and urban age-standardized mean BMI in women. a, Difference in age-standardized mean BMI in 1985. **b**, Difference in age-standardized mean BMI in 2017. We did not estimate the difference between rural and urban areas for countries and territories in which the entire population live in areas classified as urban (Singapore, Hong Kong, Bermuda and Nauru) or rural (Tokelau)—shown in grey. See Extended Data Fig. 2 for mean BMI at the national level and in rural and urban populations in 1985 and 2017. See Extended Data Fig. 6 for comparisons of the results between women and men.

*A list of authors and their affiliations appears in the online version of the paper.

The Lancet, 2016
The Lancet, 2017
Elife, 2016, 2021
Nature, 2019

The future of human (global…) health

Evolutionary Medicine as cover story, New Scientist, 2011

Evolutionary Medicine and Global Health

• Only by considering evolutionary and historic perspectives, one is able to design **effective and sustainable global health polices** for the future

• Evolutionary medicine can provide a **crucial holistic framework** for health promotion in order to increase the effectiveness of public health theory and programs

• A more profound understanding of health and disease, of the impact of environment shall lead to **better prevention and treatments**, change in lifestyle

Mastertitelformat bearbeiten

Frank Rühli and team

Current situation

- 26% of people do not have access to clean drinking water
- 720-811 million people are undernourrished
- Children under 5 years of age: 22% are stunted, 7% suffer from wasting
- The global temperature reached 1.2°C above pre-industrial baseline
- More than 25% of species are threatened with extinction
- One third of all fish stock are overfished

Covid-19 and evolutionary perspectives

Medical Hypotheses 144 (2020) 110285

Contents lists available at ScienceDirect

Medical Hypotheses

journal homepage: www.elsevier.com/locate/mehy

Letter to Editors

Do not call it COVID-19, it might have been the second wave

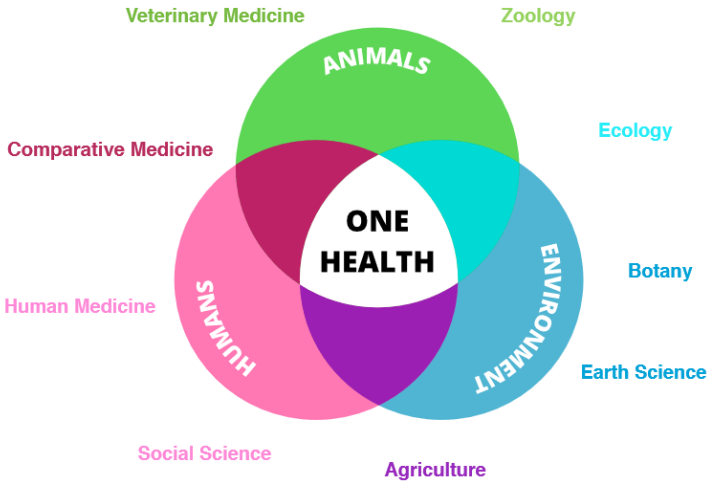
Annals of Internal Medicine HISTORY OF MEDICINE

Public Health Interventions, Epidemic Growth, and Regional Variation of the 1918 Influenza Pandemic Outbreak in a Swiss Canton and Its Greater Regions

Kaspar Staub, PhD*; Peter Jüni, MD*; Martin Urner, MD; Katarina L. Matthes, PhD; Corina Leuch, BSc; Gina Gemperle, MDentMed; Nicole Bender, MD, PhD; Sara I. Fabrikant, PhD; Milo Puhan, MD, PhD; Frank Rühli, MD, PhD; Oliver Gruebner, PhD†; and Joël Floris, PhD†

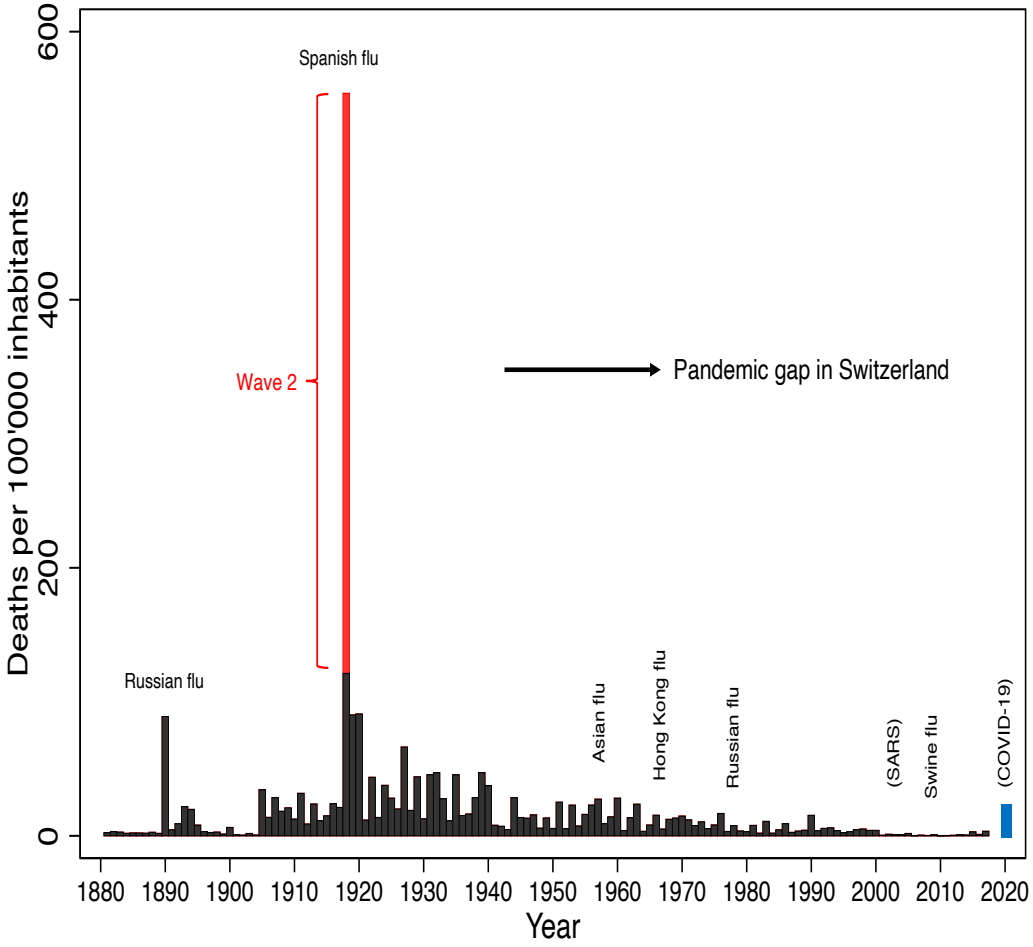
Bedeutung von evolutionärer Medizin

- Zukünftige globale Herausforderungen wie Pandemien, Umweltveränderungen oder sozio-ökonomische Probleme (Gesundheitsversorgung, Global Health Strategien) verlangen nach “critical thinking” und der Implementierung von historischem und evoutionärem Wissen (Langfristige Daten, Human Ecology inkl. Demographie, Krankheitsreservoirs, Life-Style Veränderungen)



Pestuntersuchungskasten um 1901, Medizinische Sammlung IEM

Learning from the past: The Swiss Pandemic Gap



Staub *et al.*, Swiss Med Weekly, 2021

University of Zurich[UZH]

Institute of Evolutionary Medicine

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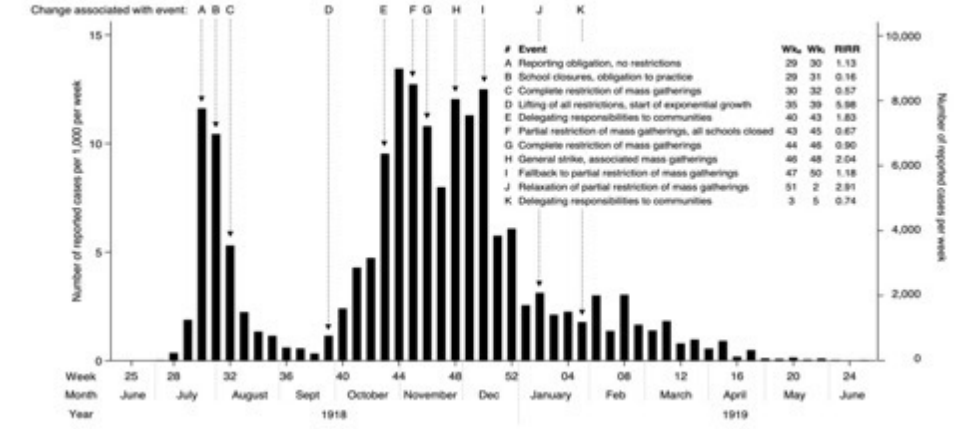
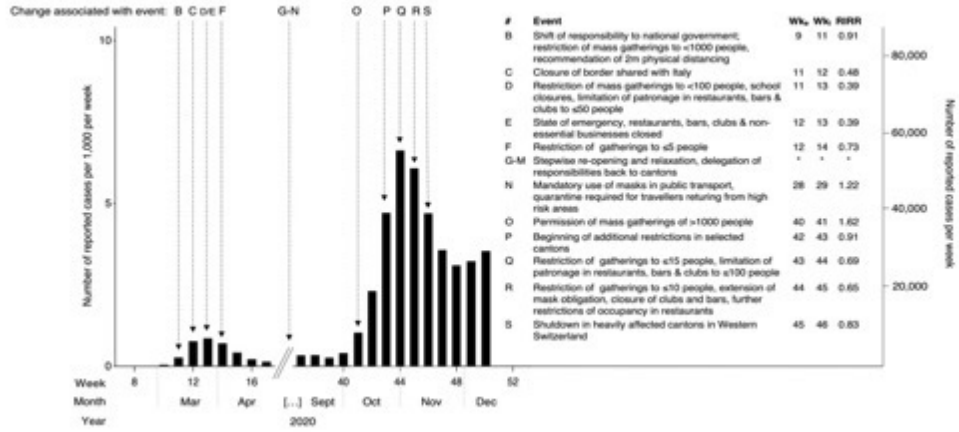
2021

a) 1918 pandemic influenza outbreak (Canton of Bern)



#	Event	Wk$_s$	Wk$_e$	RIRR
A	Reporting obligation, no restrictions	29	30	1.13
B	School closures, obligation to practice	29	31	0.16
C	Complete restriction of mass gatherings	30	32	0.57
D	Lifting of all restrictions, start of exponential growth	35	39	5.98
E	Delegating responsibilities to communities	40	43	1.83
F	Partial restriction of mass gatherings, all schools closed	43	45	0.67
G	Complete restriction of mass gatherings	44	46	0.90
H	General strike, associated mass gatherings	46	48	2.04
I	Fallback to partial restriction of mass gatherings	47	50	1.18
J	Relaxation of partial restriction of mass gatherings	51	2	2.91
K	Delegating responsibilities to communities	3	5	0.74

b) 2020 pandemic COVID-19 outbreak (Switzerland)



#	Event	Wk$_s$	Wk$_e$	RIRR
B	Shift of responsibility to national government; restriction of mass gatherings to ≤1000 people, recommendation of 2m physical distancing	9	11	0.91
C	Closure of border shared with Italy	11	12	0.46
D	Restriction of mass gatherings to ≤100 people, school closures, limitation of patronage in restaurants, bars & clubs to ≤50 people	11	13	0.39
E	State of emergency, restaurants, bars, clubs & non-essential businesses closed	12	13	0.39
F	Restriction of gatherings to ≤5 people	12	14	0.73
G-M	Stepwise re-opening and relaxation, delegation of responsibilities back to cantons	*	*	*
N	Mandatory use of masks in public transport, quarantine required for travellers returing from high risk areas	28	29	1.22
O	Permission of mass gatherings of >1000 people	40	41	1.62
P	Beginning of additional restrictions in selected cantons	42	43	0.91
Q	Restriction of gatherings to ≤15 people, limitation of patronage in restaurants, bars & clubs to ≤100 people	43	44	0.69
R	Restriction of gatherings to ≤10 people, extension of mask obligation, closure of clubs and bars, further restrictions of occupancy in restaurants	44	45	0.65
S	Shutdown in heavily affected cantons in Western Switzerland	45	46	0.83

Evolutionary Medicine als Teil von One Health

Evolutionäre Medizin ist **per definitionem** analog zu One Health: holistisch, transdisziplinär, multifaktoriell

*Evolutionary medicine or Darwinian medicine investigates **human disease vulnerability and disease aetiologies** (genetics, behaviour, environment, pathogens etc.) from an evolutionary perspective*

University of Zurich[UZH]

Institute of Evolutionary Medicine

Ann. N.Y. Acad. Sci. ISSN 0077-8923

ANNALS OF THE NEW YORK ACADEMY OF SCIENCES
Issue: *The Evolution of Infectious Agents in Relation to Sex*

One Health—One Medicine: unifying human and animal medicine within an evolutionary paradigm

Russell W. Currier[1] and James H. Steele[2]

INFECTION ECOLOGY & EPIDEMIOLOGY

REVIEW ARTICLE

The concept of health in One Health and some practical implications for research and education: what is One Health?

Henrik Lerner, PhD[1]* and Charlotte Berg, DVM, PhD[2]

Fig. 1. The 'One Health Umbrella' developed by the networks 'One Health Sweden' and 'One Health Initiative' to illustrate the scope of the 'One Health concept'. Available on www.onehealthinitiative.com and previously published in Ref. (5).

analyze some aspects of the three center green circles of health. A number of scientific fields are present under the umbrella of One Health (see the top row circles): biology, human medicine, veterinary medicine, public health, environmental chemistry, and health economy, to mention some of the most important ones. Here, our discussion will in particular relate to public health, veterinary medicine, human medicine, and ecology. We will also discuss both research and education – issues not explicitly highlighted in the umbrella picture but considered implicit for all segments and topics of the whole picture.

The paper will deal with these four topics:

of One Health provided by different international organizations in the field, please see Gibbs (5).

Other terms have also been used for similar purposes. We therefore need to dwell a little on the different terms used to demarcate the area, terms that sometimes are perceived as more or less synonymous with One Health. These are:

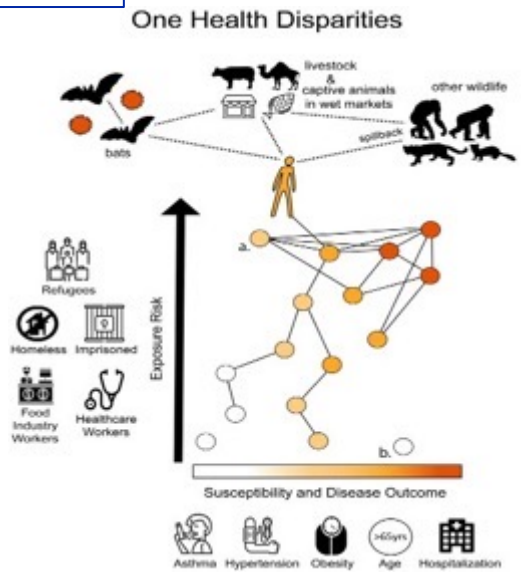
1. One medicine
2. Comparative medicine
3. Translational medicine
4. Zoobiquity
5. Evolutionary medicine

COMMENTARY

EVOLUTION, MEDICINE, & PUBLIC HEALTH

One health disparities and COVID-19

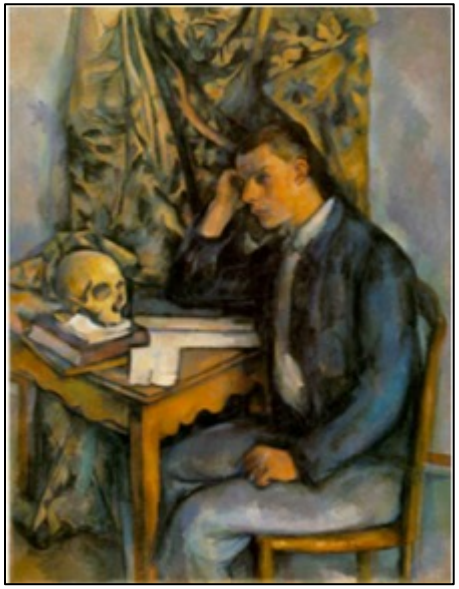
Alina Solis[1,2] and Charles L. Nunn[1,2,3]



Thank you

www.iem.uzh.ch

frank.ruehli@iem.uzh.ch



P. Cézanne, Young Man with a Skull, 1896-98