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Microbiology of beach sands and its Impact on Human Health

A systematic review

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Introduction



Beach sands

- “From a recreational viewpoint, sand beaches are sought after. Especially in higher latitudes, a significant percentage of time is spent on the beach itself rather than in the water.”
- “A number of genera and species that may be encountered through contact with sand are potential pathogens. Accordingly concern has been expressed that beach sand may act as reservoir of vectors of infection.”



World Health Organization, 2003, in
“Guidelines for safe recreational water
environments”, p118.



Regulation

- ◆ The European Bathing water Directive (Directive 2006/7/EC of the European Parliament and the Council of 15 February 2006) contemplates surrounding areas to bathing waters because those may influence water quality but....
- ◆ Doesn't specify sand-specific contaminants or sand as its own entity

**There is no legislation
or regulation in
Europe or elsewhere
in the world!**



FAQ: Can sunlight clean up?



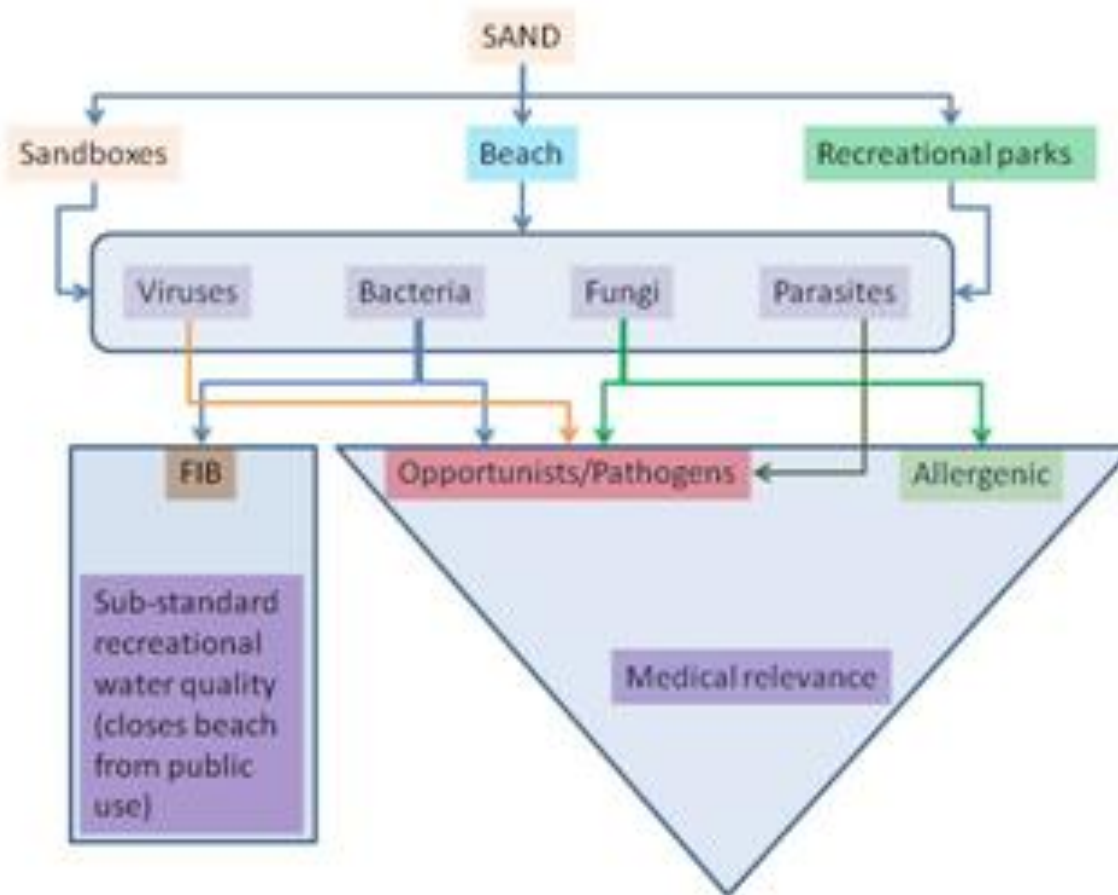
No!



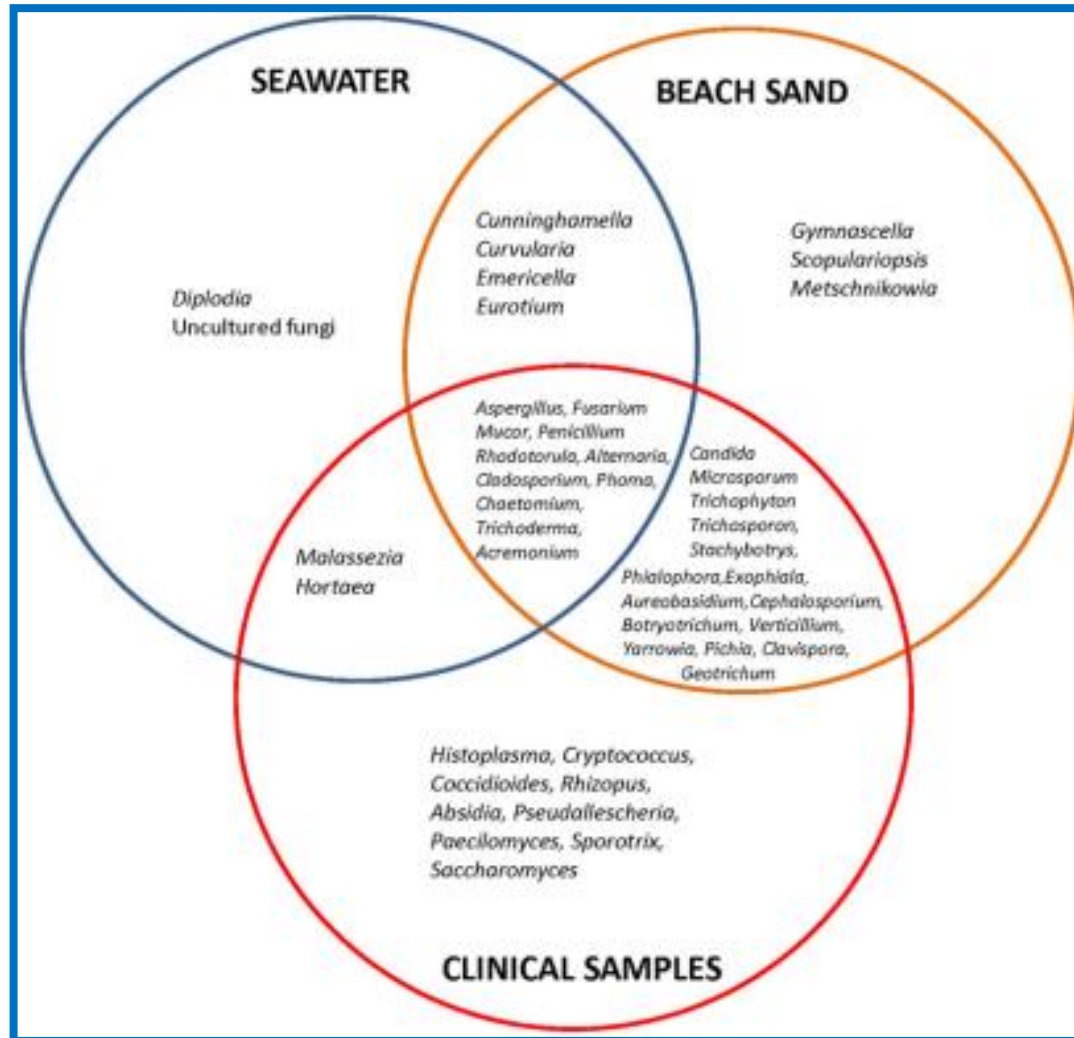
- ◆ **2009 Mika *et al.*** showed that irradiation during day time doesn't help reducing *E. coli* in the sand;
- ◆ **2012 Heaney *et al.*** showed positive relationship between sand-contact activities and enteric illness;
- ◆ Fungi are very resilient, even in drier climates and bacteria lurk under the surface



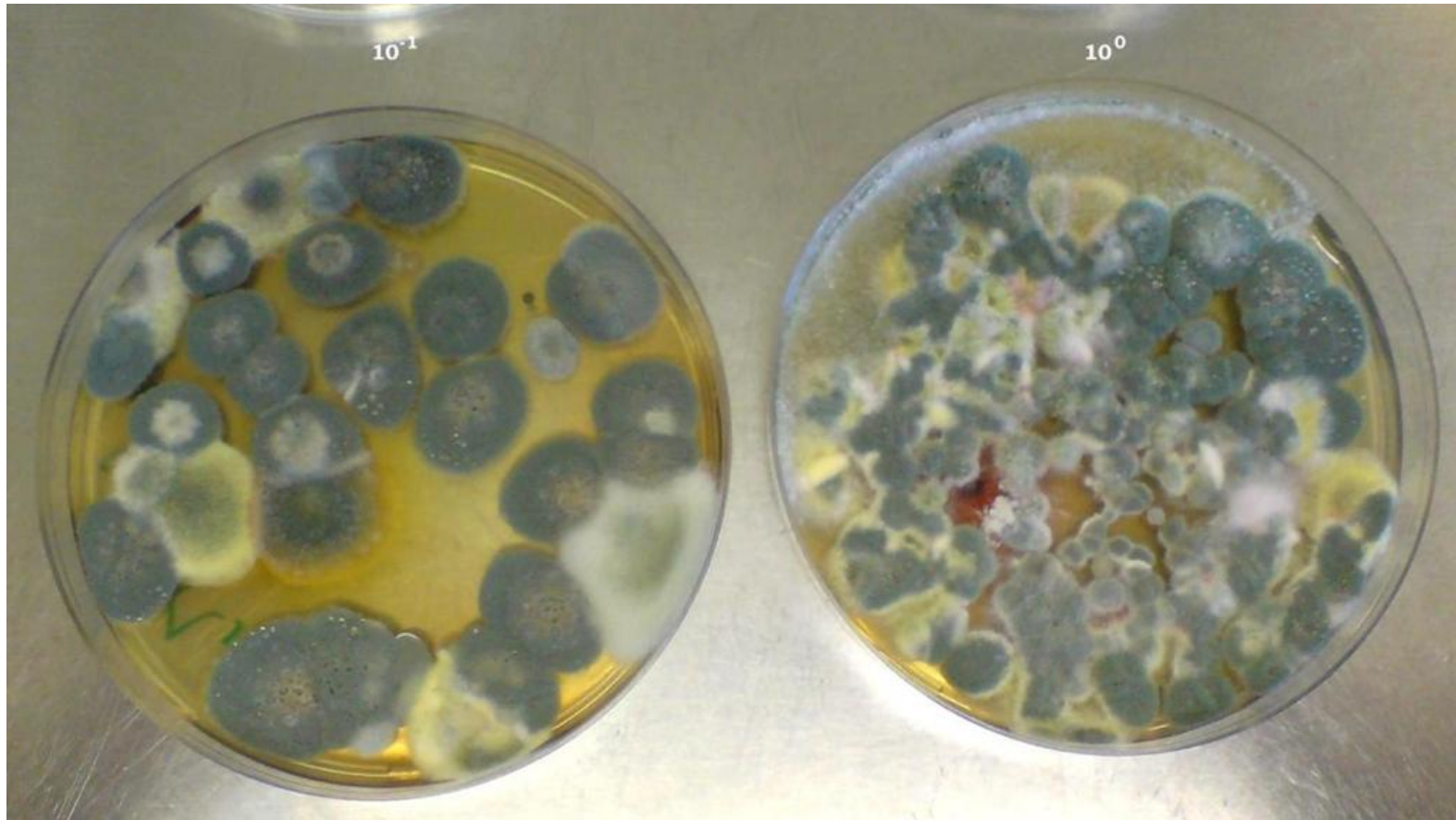
Different perspectives



Presence of fungi in environmental and clinical studies



Example of a fungal analysis (with low diversity)



Malt plates inoculated with sand wash 100 rpm/30', 1:1 w/v (10^0 and 10^{-1} dilutions) 5 days growth at $27.5(\pm 2.5)$ °C – mainly *Penicillium* spp and *Aspergillus fumigatus* visible



Reference values for sand quality assessment based on national means

Mycology Parameters:

1. Yeasts	60 cfu/g
2. Potential pathogenic moulds (filamentous fungi)	85 cfu/g
3. Dermatophytes	15 cfu/g

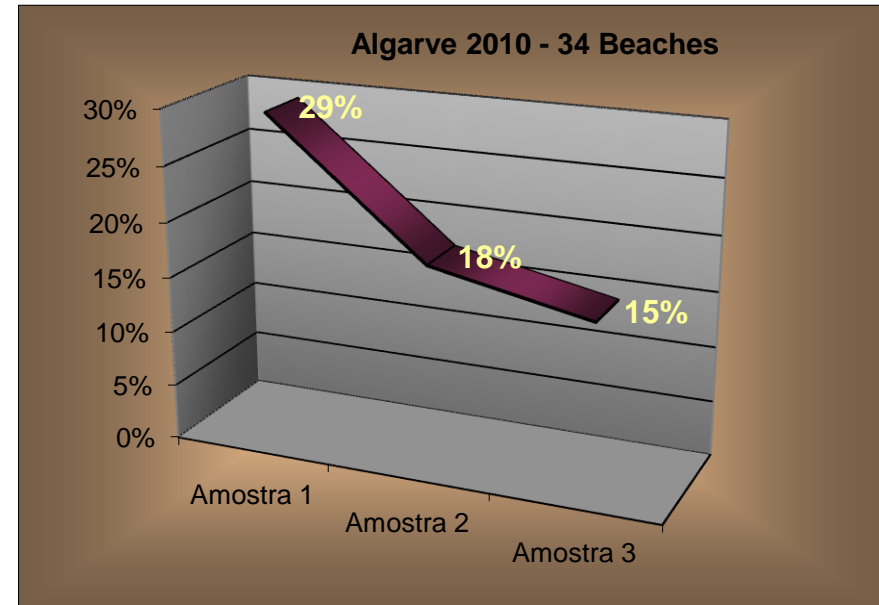
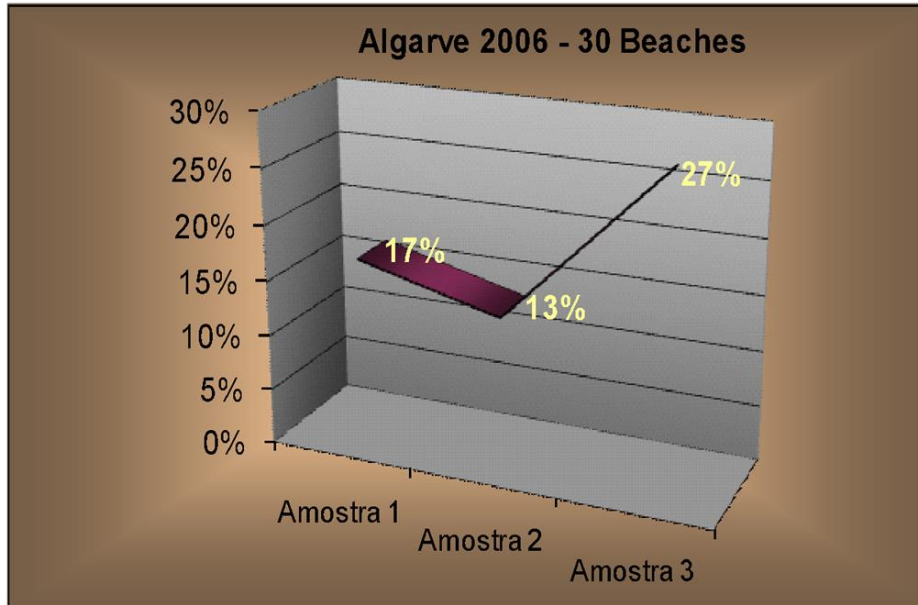
Bacteriology Parameters:

1. Total coliforms	100 cfu/g
2. <i>E. coli</i>	20 cfu/g
3. <i>Enterococci</i>	20 cfu/g



Algarve 2006 - 2010

Samples that exceeded at least one of the Reference Values



Beach managers were instructed on how to control contaminant levels.

Result: Drastic reduction of contaminant levels from the first sampling (pre-bathing season) to the following two (during bathing season) after the first year of the project (2006)



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Factors that positively influence the quality of beach sand

- **Garbage removal** - Frequent removal of litter and garbage from sand and neighbouring areas;
- **Garbage receptacles**- Number of garbage receptacles appropriate for the length of the beach;
- **Sand treatment** - based on experience of one region with weekly iodine spraying (this statement does not express the point of view of the authors);
- **Surroundings** - Identification and treatment of neighbouring contaminated areas



Factors that negatively influence the quality of beach sand

- Over-use of beach
- Admission of pets
- Accumulation of garbage
- Abandonment of remains from fishing
- Rodents and prowling animals





White Paper

Journal of the Marine Biological Association of the United Kingdom, page 1 of 20. © Marine Biological Association of the United Kingdom, 2015
doi:10.1017/S0025315415000843

Beach sand and the potential for infectious disease transmission: observations and recommendations

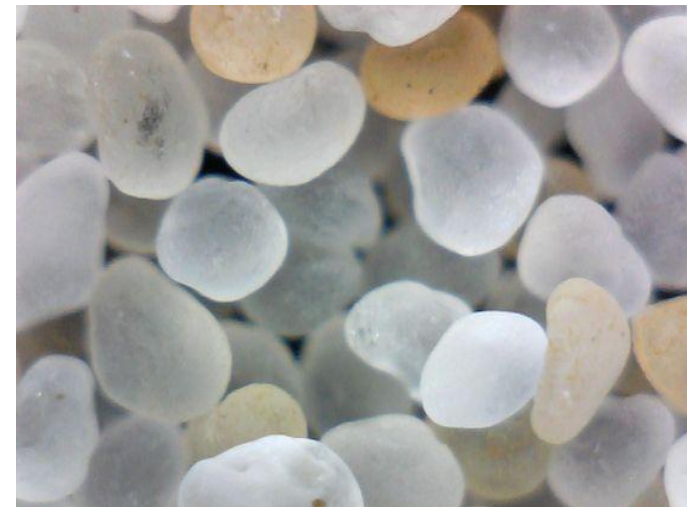
HELENA M. SOLO-GABRIELE^{1,2}, VALERIE J. HARWOOD³, DAVID KAY⁴, ROGER S. FUJIOKA⁵, MICHAEL J. SADOWSKY⁶, RICHARD L. WHITMAN⁷, ANDREW WITHER⁸, MANUELA CANIÇA^{9,10}, RITA CARVALHO DA FONSECA¹¹, AIDA DUARTE¹², THOMAS A. EDGE¹³, MARIA J. GARGATÉ¹⁴, NINA GUNDE-CIMERMAN¹⁵, FERRY HAGEN¹⁶, SANDRA L. MCLELLAN¹⁷, ALEXANDRA NOGUEIRA DA SILVA¹⁸, MONIKA NOVAK BABIĆ¹⁵, SUSANA PRADA^{19,20}, RAQUEL RODRIGUES²¹, DANIELA ROMÃO¹⁴, RAQUEL SABINO¹⁴, ROBERT A. SAMSON²², ESTHER SEGAL²³, CHRISTOPHER STALEY⁶, HUW D. TAYLOR¹⁴, CRISTINA VERÍSSIMO¹⁴, CARLA VIEGAS²⁵, HELENA BARROSO²⁶ AND JOÃO C. BRANDÃO¹⁴

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What's missing?

- More epidemiological studies to demonstrate the need to regulate;
- Regulation;
- Confirm efficiency of regulation



Fungal Epidemiological study (allergies and superficial infections)

- Most fungi are opportunistic organisms.
- Quantative Microbial Risk Assessment (QMRA) rate is low.
- Onset of infection takes days to weeks (beach users tend to go home and disperse making it almost impossible to assess outbreaks
- **Solution? Metasearch! What can be found in the literature that can suggest what the outcome of na epistudy would be.**



Research question

- Is there a relationship between exposure to beach sand and human disease due to microorganisms? (and by which agents).

Methods



PICO

Revision criteria		
	Inclusion criteria	Exclusion criteria
Study type	Observational	Qualitative, case studies, systematic reviews.
População	Young and Senior	Active (>15 - <65)
Exposition	Contaminated water Contaminated sands	Swimming pools Health club Vírus Parasites
Outcomes	Gastrintestinal disease Dermatomycoses	Systemic disease
Publication type	Scientific jornal articles	Books, book chapters, comments, editorials and thesis.
PICO – Population, Interventio/Exposure, Comparison/Control, Outcome - adaptad		



Search strategy

- MEDLINE, via PUBMED;
- GIDEON (Global Infectious Diseases database);
- Google Scholar.
- 3 queries on Title/Abstract:
 - "beach sand"
 - "mycology","fungi";
 - "gastrointestinal",
 - Manual searches in some specific journals;
- No temporal limits.

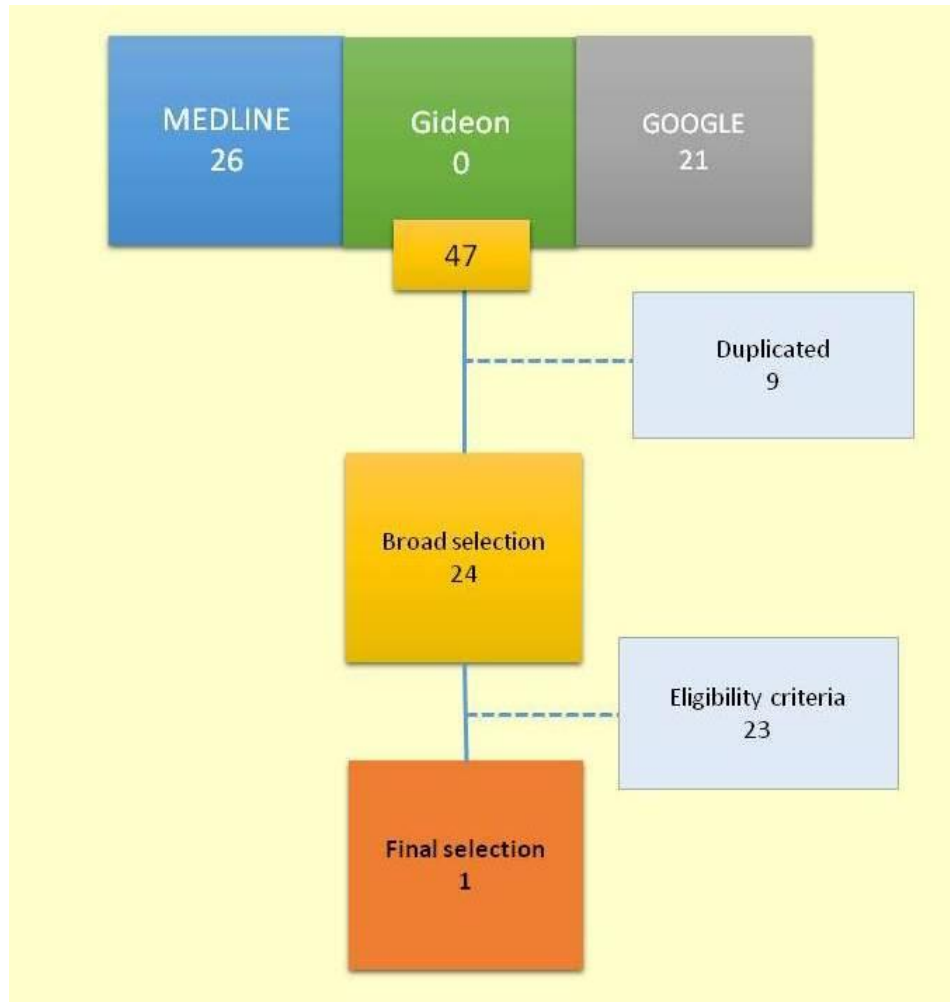


Quality criteria (STROBE, adap)

- Sample information and selection method:
 - Sample Type
 - Collection method;
- Information on the study design
 - Number of observations
 - Time spacing of observations
 - Total observation period
- Methodological aspects
 - Indication of the purpose of the study
 - Presentation of research question / hypotheses;
 - Adequacy of the statistical method used for the data type and study design;
- Indication of bias
- Indication of study limitations

Results

Flow diagram for articles selection





Fecal indicators in sand, sand contact, and risk of enteric illness among beachgoers.

Heaney CD¹, Sams E, Dufour AP, Brenner KP, Haugland RA, Chern E, Wing S, Marshall S, Love DC, Serre M, Noble R, Wade TJ.

⊕ Author information

Abstract

BACKGROUND: Beach sand can harbor fecal indicator organisms and pathogens, but enteric illness risk associated with sand contact remains unclear.

METHODS: In 2007, visitors at 2 recreational marine beaches were asked on the day of their visit about sand contact. Ten to 12 days later, participants answered questions about health symptoms since the visit. F+ coliphage, Enterococcus, Bacteroidales, fecal Bacteroides, and Clostridium spp. in wet sand were measured using culture and molecular methods.

RESULTS: We analyzed 144 wet sand samples and completed 4999 interviews. Adjusted odds ratios (aORs) were computed, comparing those in the highest tertile of fecal indicator exposure with those who reported no sand contact. Among those digging in sand compared with those not digging in sand, a molecular measure of Enterococcus spp. (calibrator cell equivalents/g) in sand was positively associated with gastrointestinal (GI) illness (aOR = 2.0 [95% confidence interval (CI) = 1.2-3.2]) and diarrhea (2.4 [1.4-4.2]). Among those buried in sand, point estimates were greater for GI illness (3.3 [1.3-7.9]) and diarrhea (4.9 [1.8-13]). Positive associations were also observed for culture-based Enterococcus (colony-forming units/g) with GI illness (aOR digging = 1.7 [1.1-2.7]) and diarrhea (2.1 [1.3-3.4]). Associations were not found among nonswimmers with sand exposure.

CONCLUSIONS: We observed a positive relationship between sand-contact activities and enteric illness as a function of concentrations of fecal microbial pollution in beach sand.

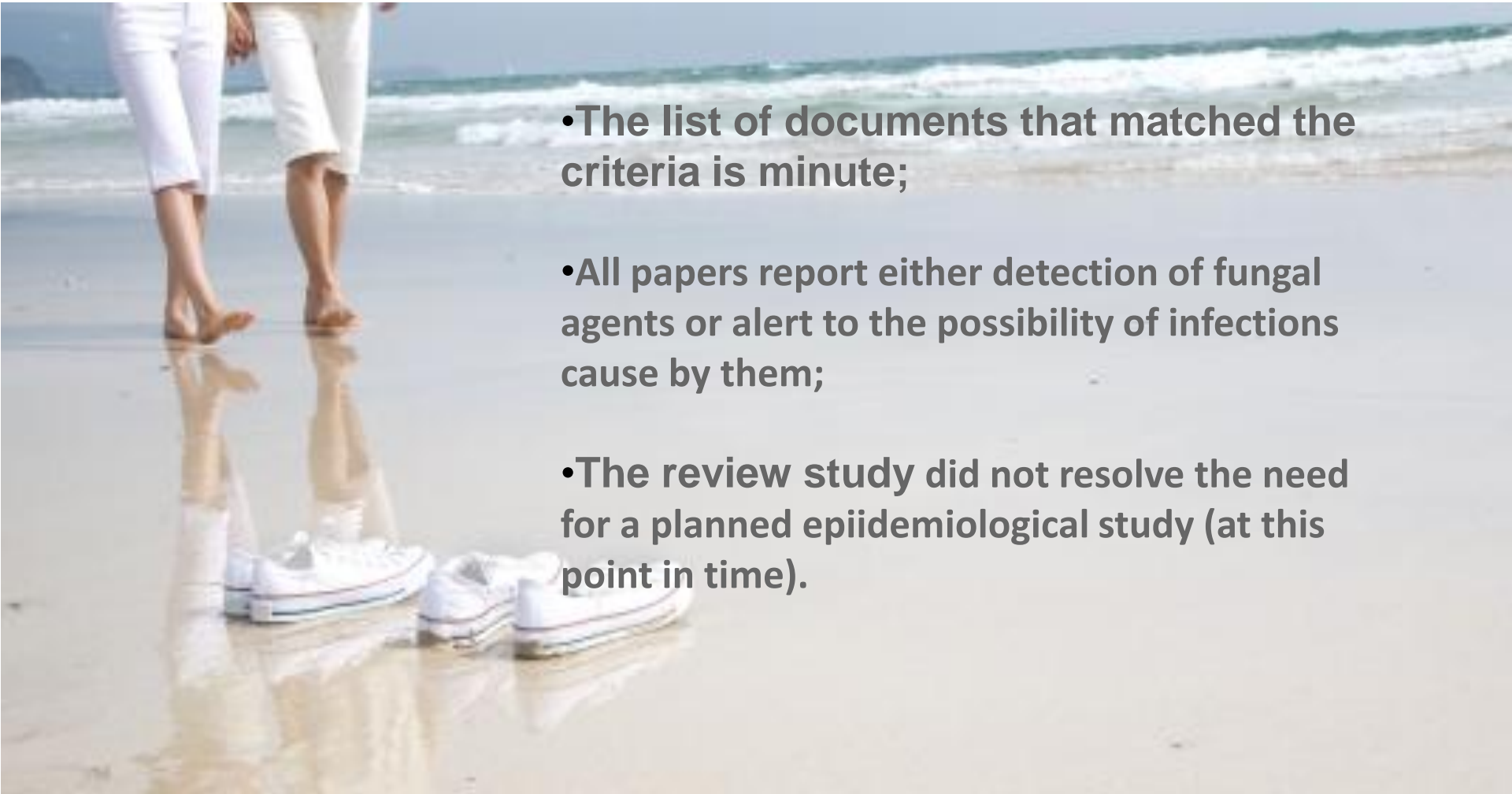


Conclusions



Conclusions

- The list of documents that matched the criteria is minute;
- All papers report either detection of fungal agents or alert to the possibility of infections cause by them;
- The review study did not resolve the need for a planned epidemiological study (at this point in time).



Thank you!!!

Barcelona, 7th September 2017

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