What can we learn from each other?
Research and tradition

Onsen in Japan

Balneology in Europe

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European Institute for Physical Therapies and Balneology
Freiburg, Germany
Japan and Germany

- Long tradition of healing with water
- (Economic) success by adaption to changes and challenges
- Nature (forest, climate) as healing factor (shinrin-yoku)
- Similar mineral waters (high CO2)
- Higher water temperatures in Japan
- Health resorts with proven quality in Germany
Summary of this lecture

• I want to show some results of recent research and discuss possible solutions and cooperation
  • Balneotherapy and CO2 in peripheral artrial disease
  • Hyperthermic baths and Sauna
  • Thermoneutral baths with and without exercise
  • Forest medicine shinrin-yoku
  • Health resorts in Germany
  • Drinking mineral waters and dementia
    • Silicea, Lithium Magnesium,
Balneotherapy in Peripheral Arterial Disease

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Freiburg, Germany
CO2 baths: physiologic basis

- Increase of cutaneous blood flow, peripheral vasodilation
- Catecholamine plasma levels decrease
- Decreased sympathetic an increased parasympathetic activity
- Thermal sensation score increases (blockage of cold receptors?)
- Bohr effect (rightward shift in \( O_2 \) - dissociation curve)
- NO-elevation, activation NO-cGMP pathway
- Induction of local VEGF

Effects of immersion in water containing high concentrations of CO2 (CO2-water) at thermoneutral on thermoregulation and heart rate variability in humans. Sato M Int J Biometeorol. 2009 Jan;53(1):25-30
Balneotherapy in Peripheral Arterial Disease

- **Carbondioxid baths**, water and gas, thermoneutral
  - 4 RCT, 2 blinded, 4 OS
- **Radon, water, hyperthermic**, 1 RCT, n=128, diabetes)
- **Waon Sauna** (2 OS, n=20, n=21)
- Hydrotherapy (Contrast showers 1 OS n=20)
- Sulphur baths (homcysteine 1 RCT, not blinded n=40)
- Galvanic baths (1 CT, not randomized, not blinded, n=111)
- Hypnosis (1 OS, n=18)

All trials show positive results
Natural CO$_2$ gas baths

- RCT, n=62, intermittent claudication (100-500 meters, moderate Fontaine stage II)
- constant temperature of 30°C on pre-humidified skin.
- 18 consecutive days of (Spa of Royat, France)
  - CO2 gas treatment
  - placebo (air).
Natural CO$_2$ gas baths

CO$_2$ gas treatment after 18 days with significant increase in
- total distance walked (+131 meters, 66%; p = 0.001)
- pain-free distance (+81 meters, 73%; p = 0.02)
- improvement maintained after 3 and 12 months
- systolic pressure index (ABI) increased by 37% (p = 0.001) 1 min after treadmill walking
- ABI recovery time decreased by 38% (p = 0.002).
- increase in systolic pressure of the great toe (13%; p < 0.0001), in baseline pO2 (20%; p = 0.01) and in vasomotion (78%; p = 0.001)

No significant change was observed in the placebo group.

Effects of hyperthermia on depression

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Hyperthermia effects

- Activates immune system
  - Heat shock proteins
- Regulates vegetative system
- Affects sleep

[Link to PMC article](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4786079/figure/F2/?report=objectonly)
Hyperthermia effects in oncology

Heat sources used for hyperthermia purposes and different mechanisms induced by locally heating tumors. The mechanism of killing tumor cells via the following aspects: (1) Direct cell-killing effects of HT alone (red); (2) Anti-neoplastic effect coordinated with radiotherapy and chemotherapy (blue); (3) Immune modulation (purple).
Hyperthermic Baths (HTB)

• Head-out-of-water-immersion in a 40°C pool
• Duration until discomfort (30 minutes)
  • Mean duration 22.6 (± 3.5) min
• Afterwards wrapped in warm blankets with 2 hot water bottles for at least 30 minutes
• 4 weeks with 2 interventions per week

Keidel-Bad Freiburg
HTB and Depression

• Non-controlled study
• 20 depressive patients
• Improvement in the 21-item Hamilton Depression Scale (HAMD) after five baths.


• Non-controlled study in depressive patients
• Effects on Heart Rate Variability (HRV)

Pilot study, parallel-group, randomized controlled trial
36 depressed patients with Hamilton Scale for Depression (HAM-D) total score ≥ 18 (mean HAM-D 22.4)
- 17 HTB
- 19 sham green light
  - < 400 Lux by an LED, < 40 min in a sitting position

HTB Core body temperature
(Ear thermometer after ca. 22 min)

• Before bath 36.6°C
• Directly after bath 39.1°C (mean change 2.43 K)
• After rest 37.7°C (mean change 1.06 K)
HTB HAM-D\textsubscript{total score} ITT analysis

3.14 points difference \((P = .031)\)

1.88 points difference \((P = .199)\)

- After 1 intervention:
  - Effect size Cohen \(d = 0.72\)

- 4 weeks after treatment:
  - Effect size Cohen \(d = 0.33\)
HTB severity of depression

Greater improvement

• With more severe depression
  • HAM-D > 22 at baseline
    • difference in HAM-D scores of 6.17
  • HAM-D > 26 at baseline
    • difference in HAM-D scores of 10.8

• In group with antidepressants

Threshold for clinical significance of the National Institute for Clinical Excellence (NICE): treatment-placebo difference of 3 points on the HAM-D
HTB Adverse effects

reported by 21 participants
• 12 (86%) in the HTB group
• 9 (56%) in the control group

No serious adverse events

But: HTB are an important cause of sudden death in Japan,
Temp of hot baths 42°C and more
HTB vs Physical exercise

• Pilot study, parallel-group, randomized controlled trial
• 45 depressed patients with Hamilton Scale for Depression (HAM-D) total score \( \geq 18 \) (mean HAM-D 21.7)
  • 22 HTB
  • 23 Physical exercise
    • in groups moderate intensity aerobic exercises

Naumann J, et al. Effects and Feasibility of Hyperthermic Baths for Patients with Depressive Disorder: A Randomized, Controlled Clinical Pilot Trial. (Under peer review in American Journal of Psychiatry)
HTB vs Physical exercise

- Significant and relevant improvement of depression and sleep after 2 weeks (ITT)
  - HAM-D  4.3
  - BDI    7.5
  - PSQI   2.0
Hyperthermia methods

Exogen
• Hyperthermic Baths
• Infrared Light, Sauna
• Capacitive fields
• Microwaves

Endogen
• Misteltoe (Lectins)
• cell extract of gram neg bacteria

Keidel-Bad Freiburg

https://www.heckel-hyperthermia.com/index.php/en05#gallery9ddb70d768-1
Correlations of effects and methods

Whole-Body-Hyperthermie and the influence of the depressive mood disorder - comparison single and seriell Interventions

- Red = seriell intervention

Endpoints of observation [weeks]

Standardized mean change for the treatment group ($\delta T$)
Correlations of effects and methods

A: max. body core temperature
- Orange = rectal
- Green = sublingual
- Red = tympanic

B: treatment time (minutes)
- Orange = infrared light
- Green = baths

C: Endpoint (weeks)
- Red = serial
- Green = single intervention

D: max. body core temperature and method to measure

K.U. Hanusch, published soon
Finish Sauna longterm effects

2000 people observed for 20 years

Sauna visits per week  1x  2-3x  4-7x

Risk for

• Sudden cardiac death  10%  8%  5%
• Mortality by CVD  22%  16%  12%
• Overall mortality  49%  38%  31%

= Risk reduction with frequent sauna

40-50% to die  50% cancer
60% for stroke  50% dementia
35-40% for respiratory diseases

Hyperthermia in depression
Conclusions

• May have a relevant effect (larger trials needed)
• Larger effects in severe depression
• Fast onset of treatment effects (IR-HT even immediate)
• Less adverse effects than many antidepressants
• HTB more helpful with antidepressant medication
• IR-HT larger and longer lasting effects

Many open questions:
• HTB or IR-WBH
• Single or seriell intervention
• Max. body core temperature …
Aquafitness-
The new trend in Balneotherapy

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Exercise on land

Exercise is very healthy
But weight is distress for joints and spine

Ideal training consists of strengthening exercises without distress

Aquafitness provides these aspects

https://www.lifeline.de/galerien/
Training of mobility

Most important
• Relief through floating
• Relaxation due to thermoneutral or warm water
• Slow movements

• In acute conditions
• Direct after operations
• Elder people

Foto: Touristeninfo Badenweiler
Mobility of the knee after operation

Yellow Land   Red water cycle
Gymnastic groups every day

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<th>Dienstag</th>
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<th>Donnerstag</th>
<th>Freitag</th>
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Training of strength

Also Water resistance important

Great variety of intensity
• Aerobic
  • Aquafitness
• Anaerobic
  • Aqua-Drill
• Resistance training for muscles
• With or without contact to floor
  – Aqua-Jogging

Foto-Credit: AquaKinetics
Devices

Enlarging surface

Larger devices
  – Aqua-Cycling
  – Aqua-Jumper

Additional motivation (music)
  – Aqua-Zumba

Foto-Credit: AquaKinetics
Aquafitness and overweight

• No weight in the water
  – Relieves strain on joints

• Water pressure
  – Improves respiration
  – More blood back to the heart

• Better cooling
  – Even in water up to 34°C
  – Enables more intense training

• Less appetite after Aquafitness in thermoneutral water
• Improves blood cholesterol
Aquafitness in overweight own study

84 healthy participants, all overweight BMI > 25 kg/m²
3 groups, Exercise 20 times in 12 weeks
• Aquafitness
• Exercise in fitness center
• Exercise at home
Aquafitness and fitness center better than exercise at home in
• Fitness-test; 6-minutes-run-test
• loss of weight about 5kg
• quality of life
Less problems with Aquafitness
Aquafitness in overweight with knee problems

87 overweight participants with knee problems
2 groups
• Aquafitness
• Exercise at home
Less weight 10kg in 6 months
Less pain in VAS 6,5 to 4,1
No improvement in group with exercise at home
Aquafitness for elderly

• Floating in the water
  – Lower risk of falls
  – Vertigo improves

• Water resistance
  – Mild training
  – Resistance adaptable anytime
  – Training with younger people easy

• Warm water
  – Relaxation of muscles

• Water pressure
  – Improves reflux of the blood
  – Good for hypertension
Forests, Shinrin-yoku and their importance for Health (Spa) resorts

Foto Eva Kempinger http://www.waldkurort.de/

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Pathways through which contact with Nature relates to Health

Natural environment
   Examples:
   - Type (e.g., urban park)
   - Quality (e.g., species diversity)
   - Amount (e.g., tree canopy near home)

Contact with nature as such
   Examples:
   - Frequency of contact
   - Duration of contact
   - Activity affordance (e.g., for viewing, for walking)

Air quality
   Examples:
   - Reduction of particulate matter
   - Increase in ozone
   - Increase in aeroallergens

Physical activity
   Examples:
   - Increased walking for recreation
   - Increased outdoor play

Social contacts
   Examples:
   - Increased interaction with neighbors
   - Increased sense of community

Health and well-being
   Examples:
   - Performance (e.g., academic, occupational)
   - Subjective well-being (e.g., happiness)
   - Persistent physiological changes (e.g., high cortisol levels)
   - Morbidity (e.g., CHD, depression)
   - Mortality (e.g., CVD, all cause)
   - Longevity

Stress
   Examples:
   - Reduction of stressor exposures
   - Acquisition of coping resources
   - Affective, cognitive, physiological restoration

Effect modifiers 1
   Examples: Distance, other accessibility factors, weather, perceived safety, socioeconomic status, occupation, societal/cultural context

Effect modifiers 2
   Examples: Gender, age, socioeconomic status, occupation, societal/cultural context
Pathways through which contact with Nature relates to Health

**Immunological view**

- Evolutionarily determined need for diverse microbial input to immune system
- Increase microbial load & biodiversity in home
- Exchange of microbiota
- Exchange of microbiota
- Vitamin D and NO improve immunoregulation
- More Treg, immunoregulation

**Green Space Effect**

- Walk in green space
- Dogs
- Social interaction
- Team sport
- Sunlight
- Exercise

**Clinical outcomes**

- Low CRP, low inflammation
- Lower cytokine response to stress, more stress resilience
- Less deaths, less CVD
- Less depression

**Psychological view**

- Evolutionarily determined psychological need (habitat selection ?)
- Psychologically rewarding companion
- Build social capital
- “Hunter-gatherer” activity
- Combat Seasonal Affective Disorder
- Health benefits, weight loss
- Relaxation and exercise ?
- Relaxation, restoration, social capital ?
Air Quality

- Trees reduce levels of air pollutants [e.g., ozone, oxides nitrogen (NOx), oxides of sulfur] and PM
- reduce air movement

### Table 4.2  Potential effects of forests on deposition fluxes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Moorland</th>
<th>Forest</th>
<th>% increase forest/moor</th>
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<tbody>
<tr>
<td>Canopy height</td>
<td>$h$ (m)</td>
<td>0.15</td>
<td>10</td>
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<tr>
<td>Zero plane displacement</td>
<td>$d$ (m)</td>
<td>0.1</td>
<td>7</td>
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<tr>
<td>Roughness length</td>
<td>$z_0$ (m)</td>
<td>0.01</td>
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<td>Friction velocity</td>
<td>$u^*$ (m s$^{-1}$)</td>
<td>0.32</td>
<td>0.82</td>
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<tr>
<td>Momentum flux</td>
<td>$\vartheta$ (N m$^{-2}$)</td>
<td>131</td>
<td>840</td>
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<tr>
<td>Maximum deposition velocity for SO$_2$</td>
<td>$V_{\text{max}}$ SO$_2$ (mm s$^{-1}$)</td>
<td>18.6</td>
<td>35.1</td>
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<td>Maximum deposition velocity for NO$_2$</td>
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<td>Maximum deposition velocity for NH$_3$</td>
<td>$V_{\text{max}}$ NH$_3$ (mm s$^{-1}$)</td>
<td>21.4</td>
<td>55.5</td>
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</table>
Air Quality, Forrest (Schwarzwald)

- Source of hydrocarbons, including isoprene and terpenes.
Physical Activity

promotes physical and mental health across the life span

Association of NE and physical activity
• Children: positive in 40% of the studies
• Older people: positive in 7 out of 8 studies
• Health benefits largest among the laziest

Important
• Individuals’ (perceived) safety
• Accessibility

Estimated frequency of participation in close-to-home outdoor recreation per week in two different recreation opportunity situations, with 30% respectively 60% of the total neighborhood area consisting of green space (Neuvonen et al. 2007)
Social Cohesion

positive association between social relationships and health and well-being
association between social cohesion and
• greenness of the neighborhood Sugiyama et al
• quantity and even stronger quality of greenery. De Vries et al
Stress reduction Influence on Cortisol

**Graph:**
- **Y-axis:** Cortisol concentration (µg/dl)
- **X-axis:**
  - Morning
  - Post-Walk
  - Post-Watch
  - Pre-Walk
  - Pre-Watch
  - Evening
- **Legend:**
  - Forest area
  - City area
- **Statistical Note:** p<0.059
- **Significance:** *

**Bar Graph Details:**
- Morning: Higher cortisol levels for both areas, with a slight decrease post-walk for both.
- Post-Walk: Significant decrease in cortisol levels in the forest area compared to the city area.
- Post-Watch: Further decrease in cortisol levels, with a notable difference between forest and city areas.
- Pre-Walk: Cortisol levels are lower than morning but higher than evening.
- Pre-Watch: Similar levels to pre-walk.
- Evening: Lowest cortisol levels across all conditions, with no significant difference between areas.

**Interpretation:**
- The study suggests that exposure to natural environments (forest area) reduces cortisol levels compared to urban settings (city area), especially following physical activity (post-walk) and mental activity (post-watch).
Blood pressure and distress (Qing Li u. a. 2011).

**Fig. 2** Effect of walking in a forest park and walking in an urban area on the levels of systolic (a) and diastolic (b) blood pressure. Data are presented as the mean ± SE ($n = 16$). *$p < 0.05$, **$p < 0.01$, significantly different between the forest and urban trips according to the paired $t$ test.

**Fig. 3** Effect of walking in a forest park and walking in an urban area on urinary adrenaline (a), noradrenaline (b), and dopamine concentrations (c). Data are presented as the mean ± SE ($n = 16$ for adrenaline and $n = 14$ for noradrenaline and dopamine). *$p < 0.05$, **$p < 0.01$, significantly different between after and before according to the paired $t$ test.
Effects of different NE
Wild or cultivated forest

Design experimentelle Studie 1: in situ

„verwildelter“ Wald

Befindlichkeits-Skalen
Vorher-Messung

zufällige Zuordnung

30 Minuten

„gepflegter“ Wald

Befindlichkeits-Skalen
Nachher-Messung
Wild or cultivated forest

Vergleich zwischen Bedingungen

Wald "verwildert in situ"
Wald "gepflegt in situ"

Kovarianzanalyse, Kovariate t1, Abhängige Variable t2-t1; Irrtumswahrscheinlichkeiten:* p<.05, ** p<.01, *** p<.001.
Forests in therapy

• Erholungswald recreation forest
  • For all people, clean air

• Kurwald „health forest“
  • Also ill people, secondary prevention, therapeutic walking, adequate infrastructure

• Heilwald „healing forest“
  • Mainly therapeutic use, accessible only for the target group (patients), more special infrastructure
Conclusion

• The scientific literature relating to the effects of shinrin-yoku is still limited.
• Forests have a positive influence on health and wellbeing of people living close to it.
• They have also a positive effect on health and wellbeing, if these places are visited for a certain even short time.
• Even artificial substitutes for forests show positive effects.

• Health resorts mainly situated in natural environments and forests can use the environment as helpful tools to achieve more physical activity and stress reduction in the general population and patients, esp. with chronic diseases related to lifestyle.
Medical spa treatment in Baden-Württemberg, Germany: A survey of spa physicians 2016

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Freiburg, Germany
Health Resorts (HR) in Germany

Balneotherapy (onsen) is applied in villages committed to the health = Health Resorts
Certified and controlled by the government (special laws)

Qualities of HR
• Clean air, no noise, little traffic, nature
• Culture, music, parks, hotels, healthy food, …
• Medical institutions and staff
• Physical therapies, Physiotherapy, Sauna, Inhalation,
Balneotherapy in Health resorts

Balneotherapy uses local natural healing remedies

• Thermal mineral water
• Gases: $\text{CO}_2$, radon, sulphure
• Mud (peloids)
  • organic
  • anorganic (vulcanic stone powder with water)
• Climate
Survey of Balneotherapy in Baden-Württemberg

• 56 Health resorts
• 156 Health resort physicians

Questionnaire to all physicians

Interview per telephone with at least 1 Health resort physician per Health resort, possibly all.
state, that health resort medicine can relevantly contribute to solve big health problems as chronic pain, elder patients, overweight but it is necessary to show the possible benefits to insurances, other physicians and patients.
Indications in HR

• Musculoskeletal system (back pain, osteoarthritis)
• Relatives of patients visiting rehabilitation clinics
• Overweight
• Respiratory diseases, allergies
Outcome in HR

Outcome of patients excellent
Relevant amelioration in 70 - >90% for nearly all indications
Esp. Musculoskeletal system
Effectiveness of natural remedies
Judged by Health resort physicians

Mineral Water/Bath

- Little: 2
- Large: 11
- Not used: 15

Mineral Water/Drinking Cure

- Little: 7
- Medium: 7
- Large: 15
- Very Large: 20
- Not used: 0
Effectiveness of natural remedies
Judged by Health resort physicians

Mud

- Little: 7
- Medium: 1
- Large: 3
- Very Large: 6
- Not used: 19

Fango

- Little: 1
- Medium: 8
- Large: 15
- Very Large: 7
- Not used: 5
Effectiveness of natural remedies
Judged by Health resort physicians

Healthy Climate

Kneipp

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<th>Effectiveness</th>
<th>Healthy Climate</th>
<th>Kneipp</th>
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<tr>
<td>Not used</td>
<td>13</td>
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Health ressorts are the ideal places
• High attraction
• High acceptance
• High adherence
• Long tradition of teaching and curing
• Experience with complex therapies for complex problems
• Salutogenetic principle
Chronic, lifestyle-related diseases
A Place for Health ressort medicine

- Acute and/or intense therapy: operation, syringes, ICU
- Intense, complex therapy for functional problems
- Intensity adapted complex therapy for complex problems, natural remedies and prevention
- Minor problems, relaxation or activity is enough
- All kind of problems, before and after the other therapies
- Hospitals
- Rehabilitation clinics
- Health ressorts with Medicine and/or Medical Wellness
- Holidays
- Ambulant medicine (therapies at home)
Drinking water to prevent dementia
Dr. med. Johannes Naumann
European Institute for Physical Therapies and Balneology
Freiburg, Germany
Silicic acid and Alzheimer disease (AD)

Risk reduction with silicic acid in drinking water in 2 cohort trials from France between

11% for each 10 mg/day more (n=3777)
36% for > 12 mg/day vs < 12 mg/day (n=383)

Main source for silicic acid mineral water
(silicic acid 8.8-35.7 mg/l),
Tap water contributed only with ca. 25%
(silicic acid 4.0-11.2 mg/l)
Water from Taketa (Naoiri) 230mg/l !


Meta-analysis silicic acid and AD

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<th>SE</th>
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<td>Gillette-Guyonnet et al. 2005 (1)</td>
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<td>0.4703</td>
<td>31.2%</td>
<td>2.74 [1.09, 6.89]</td>
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<td>Rondeau et al. 2009 (2)</td>
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<td>0.1558</td>
<td>68.8%</td>
<td>1.33 [0.98, 1.81]</td>
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<td>Subtotal (95% CI)</td>
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<td></td>
<td>100.0%</td>
<td>1.67 [0.86, 3.21]</td>
</tr>
</tbody>
</table>

Heterogeneity: $\text{Ta}u^2 = 0.14; \chi^2 = 2.13, \text{df} = 1 (P = 0.14); \text{I}^2 = 53\%$
Test for overall effect: $Z = 1.52$ ($P = 0.13$)

Test for subgroup differences: Not applicable
(1) Silica intake $\leq 4 \text{ mg/d}$ vs. $> 12 \text{ mg/d}$ vs.
(2) Silica intake $\leq 5.86 \text{ mg/d}$ vs. $> 15.45 \text{ mg/d}$ vs.
Lithium and AD

2015 systematic review with meta-analysis
3 RCT n=232
Lithium significantly reduced mental decline of AD patients
\( (SMD \, d = -0.41, \, 95\% \, CI = -0.81 \, to \, -0.02, \, p = 0.04) \) (Matsunaga 2015).

This effect size is twice as large as the effect of approved drugs for the treatment of AD (Ströhle et al 2015).


Lithium and AD

Microdoses of lithium (0.3 mg per day) for 15 months reduced the mental decline of Alzheimer's patients small RCT and in an animal model

Magnesium (Mg) and AD

• lower content of Mg of AD patients
  • in brain tissue (Glick 1990) (Andrási et al. 2005)
  • in the blood (Barbagallo et al. 2011)
  • in cerebrospinal fluid and hair (Veronese et al. 2016)
• correlation of blood levels of Mg with the severity or the course of AD (Cilliler, Ozturk, and Ozbakir 2007)
• But: also elevated serum levels of magnesium in dementia (Kieboom et al., 2017)
• long-term increase in dietary magnesium intake has a positive influence on cognitive abilities (Cherbuin et al., 2014).
• case report: 2 x 500 mg magnesium daily dramatically improved the course of the disease for an AD patient temporarily (Glick and McMillan 2016).
Water analysis Naoiri (Kyushu, Japan)

Silicic acid 230 mg/l
Lithium 0,6 mg/l
Magnesium 268 mg/l

0,5 l per day fulfill the amount needed for prevention of AD

- Silicic acid 115 mg
  - 11%-risk-reduction for each 10mg
- Lithium 0,3 mg
- Magnesium 134 mg)
Thank you for your attention and let us work together.