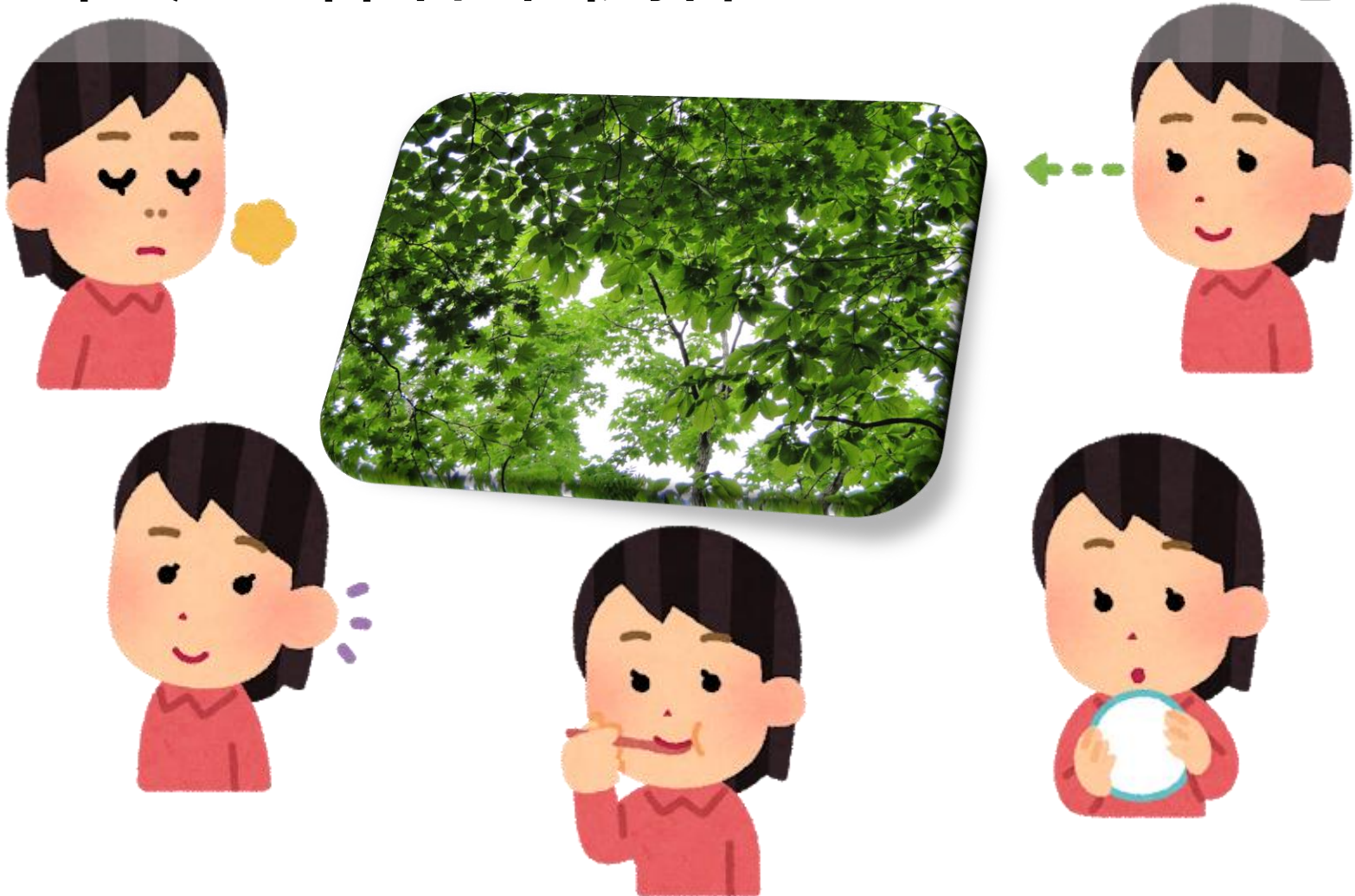


# 「国内外の先行研究の収集・整理」 の方向性(案)

「森林サービス産業」検討委員会 エビデンス専門部会(第1回)資料を一部抜粋・修正

国立研究開発法人森林研究・整備機構  
森林総合研究所 ダイバーシティ推進室 室長  
高山 範理

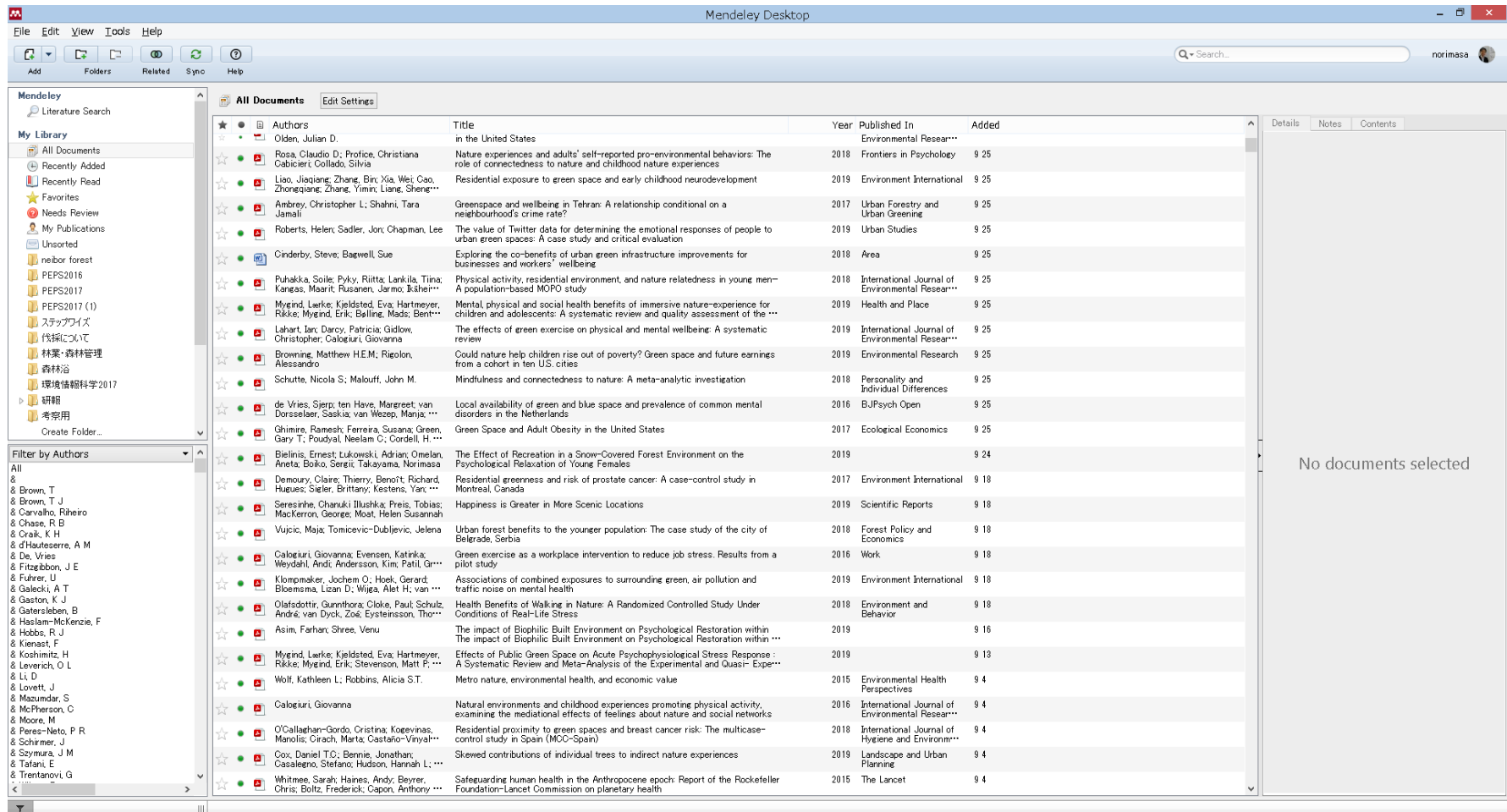
# 昨今の森林浴関係エビデンスの感触



⇒①Place Visiting : 森林内での滞在／活動が“からだ”・“こころ”が直接的に受ける効果の評価(直接体験の評価)

⇒②Living Environment: 居住環境における森林の量や距離や接触頻度から受ける効果の評価(生活環境の評価)

# Mendeley



- ・文献整理ソフトウェア
- ・約2,000編の関連論文(主に英語文献)

# ① Place Visiting

## 英語にて公開された論文数

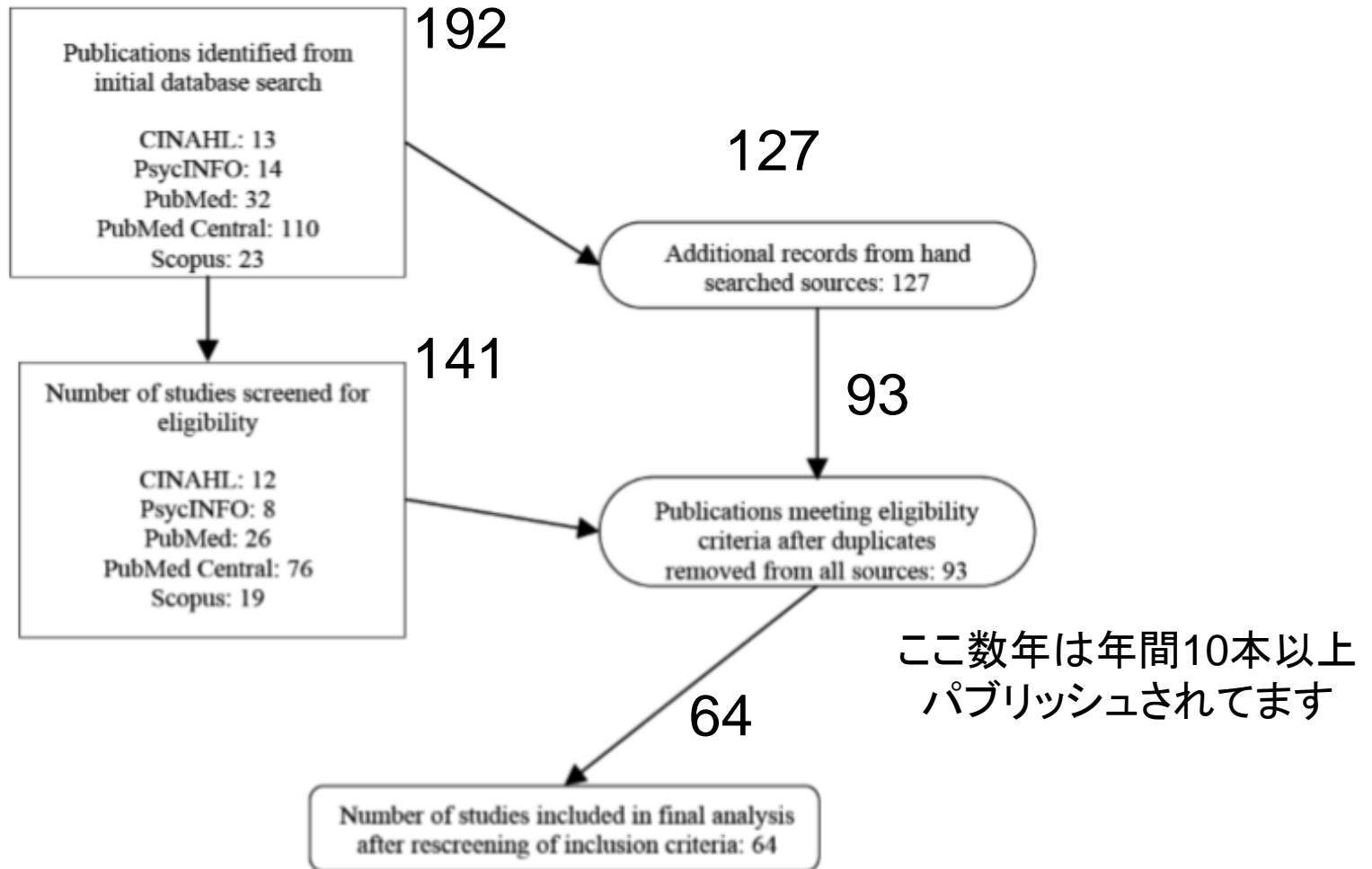
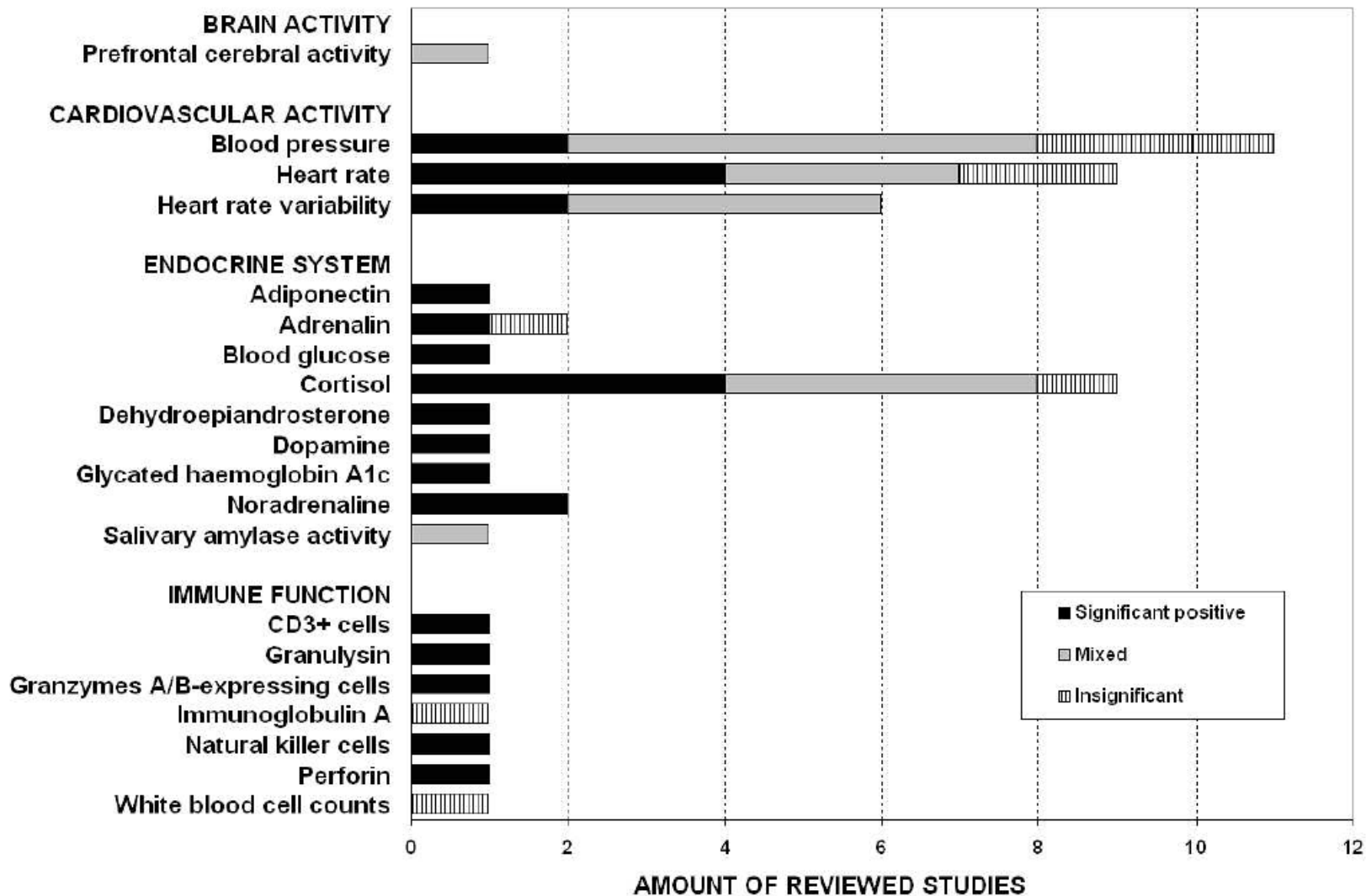


図 2007年～2017年の間の関連論文(英語)

# ① 身体的な評価指標



# ① 血圧・脈拍

Table 1: Significant Findings for Heart Rate and Blood Pressure

<i>Study</i>	<i>Method</i>	<i>Pulse/Heart Rate</i>	<i>Diastolic</i>	<i>Systolic</i>	<i>Blood Pressure</i>
<i>Yu et al. (2017)</i>	Original	**	**	**	
<i>Ideno et al. (2017)</i>	Systematic review	**	**	**	**
<i>Hansen et al. (2017)</i>	Review	*			*
<i>Ochiai et al. (2015)</i>	Original		**	**	
<i>Song et al. (2016)</i>	Review	*	*	*	*
<i>Lee et al. (2014)</i>	Original	**	-	*	
<i>Song et al. (2013)</i>	Original	#**	#**		
<i>Mao et al. (2012a,b)</i>	Original	*	*	*	
<i>Lee et al. (2011)</i>	Original	**	-	-	
<i>Park et al. (2010)</i>	Review	*	*	*	*
<i>Tsunetsugu et al. (2010)</i>	Review	*			*
<i>Ohtsuka et al. (1998a,b)</i>	Original	-			*

Source: Data Compiled by the Authors

Note: \*\*p<0.01, \*p<0.05 indicates statistically significant, dashes (-) signify no significant difference, #Type B behaviour pattern (Song et al. 2013).

# ①体内ホルモン等

Table 2: Biomarker Variations Demonstrating Forest Bathing Benefit

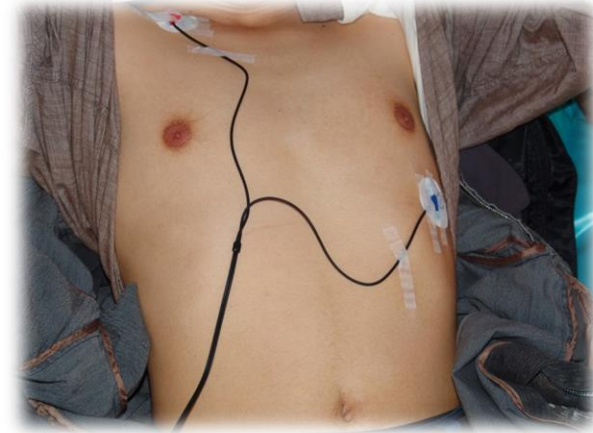
<i>Study</i>	<i>Method</i>	<i>Cortisol</i>	<i>Amylase</i>	<i>Adrenaline Noradrenaline</i>	<i>Dopamine</i>
<i>Hansen et al. (2017)</i>	Review	V*	V-	V*	
<i>Bing et al. (2016)</i>	Original	V*		V*	
<i>Li et al. (2016)</i>	Original			V*	^*
<i>Song et al. (2016)</i>	Review	V*		V-	
<i>Ochiai et al. (2015)</i>	Original	V*		V*	
<i>Mao et al. (2012b)</i>	Original	V*			
<i>Lee et al. (2011)</i>	Original	V*			
<i>Qing et al. (2010)</i>	Review			V*	
<i>Park et al. (2010)</i>	Review	V*	V-		
<i>Tsunetsugu et al. (2010)</i>	Review	V*			
<i>Li et al. (2008a)</i>	Original			V*	
<i>Li et al. (2008b)</i>	Original			V*	
<i>Yamaguchi et al. (2006)</i>	Original		V-		

Source: Data Compiled by the Authors

Note: V\* significant decrease ( $p < 0.05$ ), ^\* significant increase ( $p < 0.05$ ), V- decrease not significant ( $p > 0.05$ ).



# ① 主な評価指標 (身体)



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短期滞在効果	唾液中アミラーゼ・唾液中コルチゾール・血圧 (収縮期・拡張期)・脈拍・副交感神経活動・交感神経活動・脳血流量
生理尺度	
長期滞在効果	NK細胞・抗がんタンパク・免疫グロブリン・アドレナリン・ノルアドレナリン

---

⇒ 評価指標が絞られてきた感があります



# ① 主な評価指標 (心理)



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短期滞在効果	POMS・STAI (state-trait anxiety inventory)・PANAS・ROS・SVS・VAS (visual analogue scale)・TMS (temporary mood scale)
心理尺度	
長期滞在効果	SCI・WHOQOL26・S-H式レジリエンス検査・GSES・TBS

---

⇒心理尺度では妥当性、信頼性の確認された調査票が用いられます

## ②Living Environment

Effect of exposure to natural environment on  
health inequalities  
: an observational population study

Richard Mitchell, Frank Popham.(2008)  
*The Lancet* 372(9650):pp.1655-1660

### ➤結論：

- ・所得の違いによってもたらされる健康の不平等性  
：緑が豊かな所ではその差異が小さい



疫学的に自然環境の健康への効用を明らかにした初めての研究

## ➤ 調査手続き

① 英国の緑の豊かさの差が顕著な地区を選定

② 緑地 (Green) の割合別に被験者を5つのグループに分ける  
(n=40,813,236)

③ 2001年から2005年の死亡記録(年齢、性別、死因)を取得  
(n=366,348)

- \* 自然環境以外の影響を排除する為、死因を統制
- \* 特に循環器系疾患、肺癌、意図的な自己害に注目

④ 所得別に被験者を4つのグループに分ける

Rich ← Less Green ———— 表 緑の豊かさ と 収入 ———— → Much Green

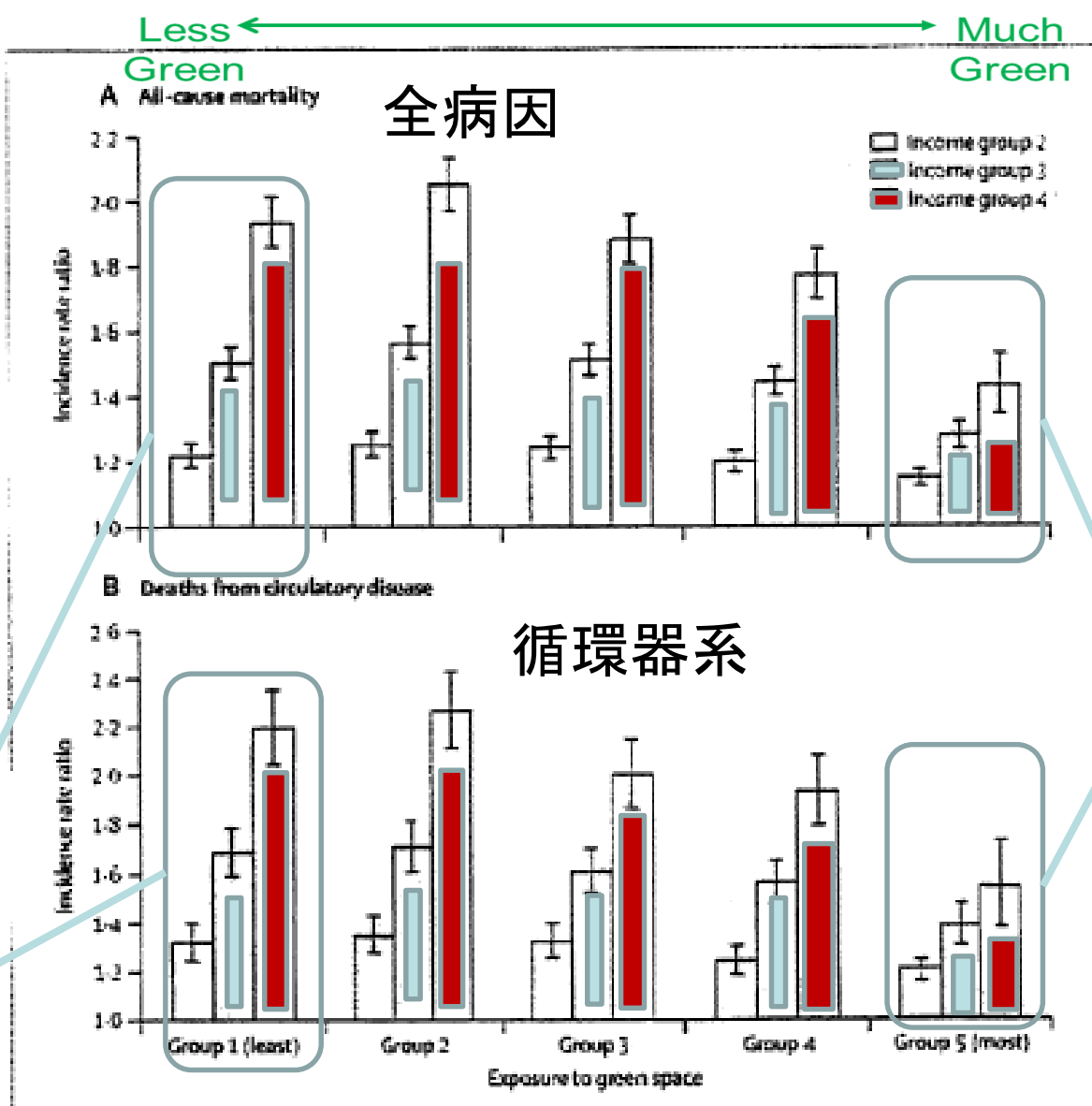
	Groups of exposure to green space					Total
	1 (least exposed)	2	3	4	5 (most exposed)	
Income-deprivation group 1 (least deprived)	1 497 663	1 512 733	1 756 134	2 503 755	3 716 717	10 987 002
Income-deprivation group 2	1 757 904	1 617 400	1 720 964	2 080 000	2 891 637	10 067 905
Income-deprivation group 3	2 291 828	2 033 620	2 025 834	1 821 320	1 161 087	9 333 689
Income-deprivation group 4 (most deprived)	2 797 692	2 983 898	2 591 694	1 654 367	396 989	10 424 640
Total	8 345 088	8 147 653	8 094 629	8 059 446	8 166 435	40 813 236

Table: Study population size, stratified by exposure to green space and by income deprivation

Poor

➤結果

各グループの死亡比率

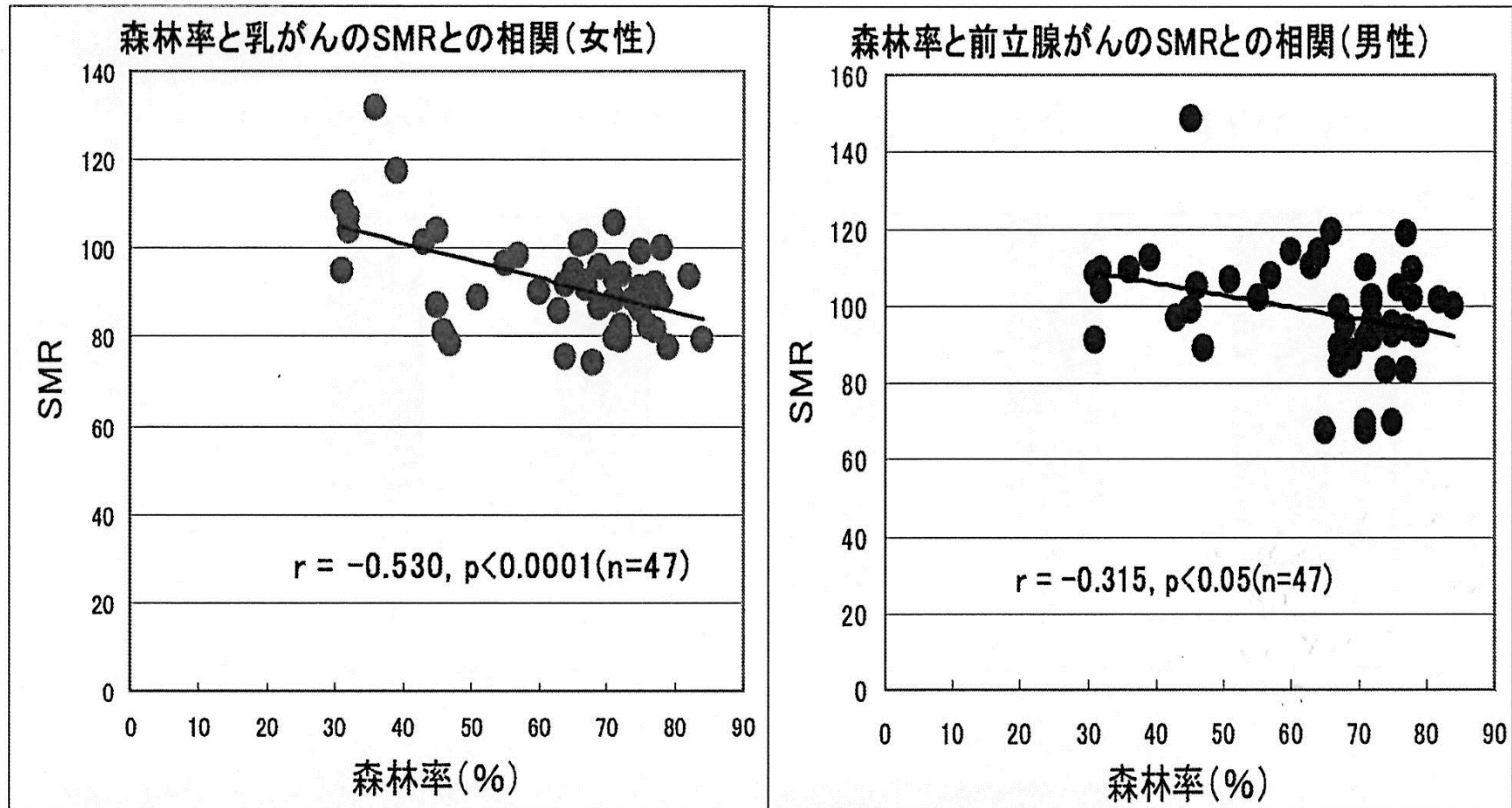


(収入)グループ間の差が小さい

(収入)グループ間の差が大きい

⇒かなりショッキングな研究成果でした

## ② 森林率と標準化死亡比 (SMR)

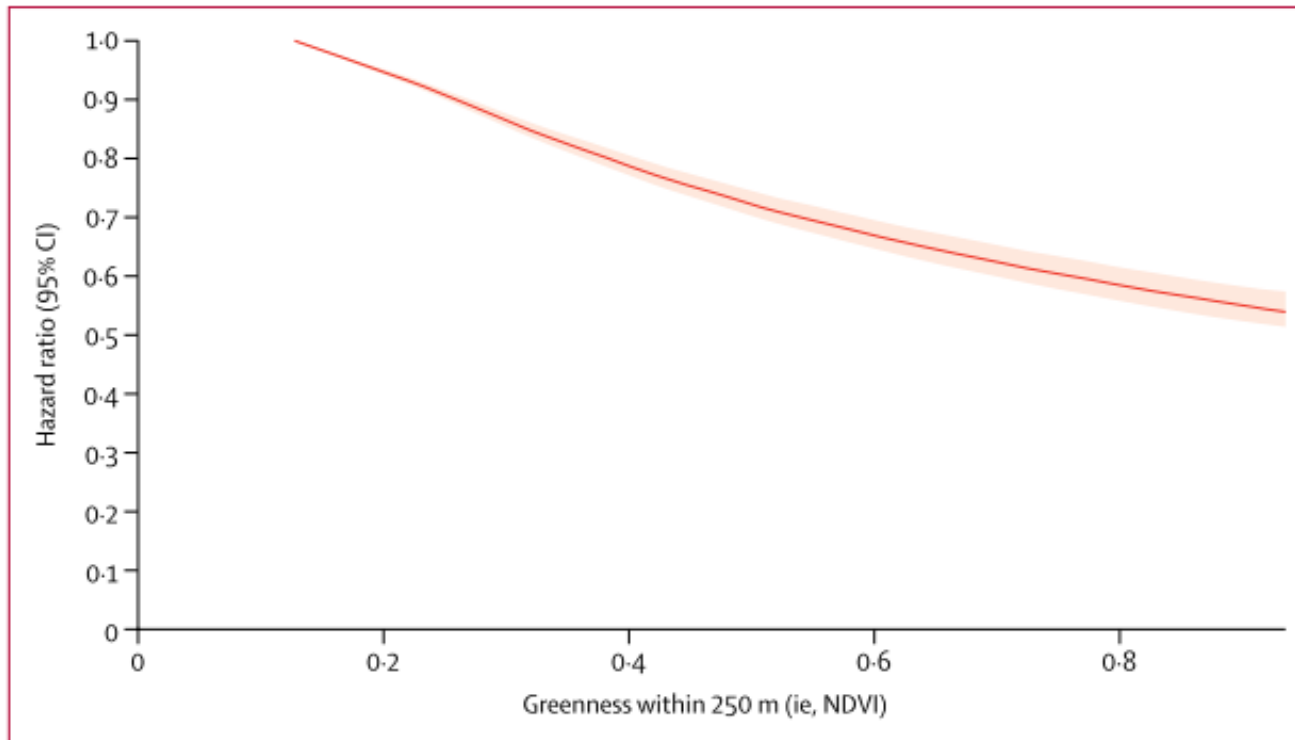


Li Q, Kobayashi M, Kawada T. Relationships between percentage of forest coverage and standardized mortality ratios (SMR) of cancers in all prefectures in Japan. The Open Public Health Journal 2008; 1, 1-7.



## ②カナダのコーホート研究

危険率



**Figure: Concentration–response plot for mortality and greenness**

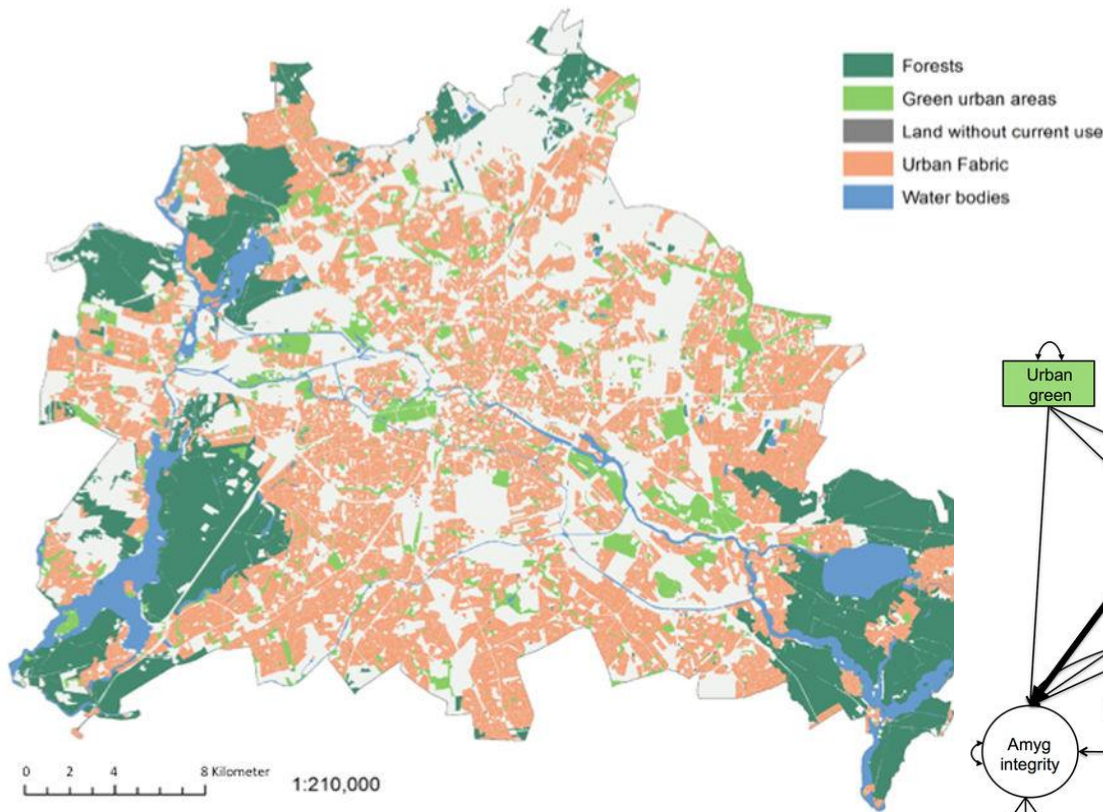
Data are hazard ratios (dark red line) and 95% CIs (light pink shading) for mortality association with greenness within 250 m of participants' residences from model 9 (as described in table 2). NDVI= Normalized Difference Vegetation Index.

n=126万人

住宅地から  
250m以内の  
みどりの量

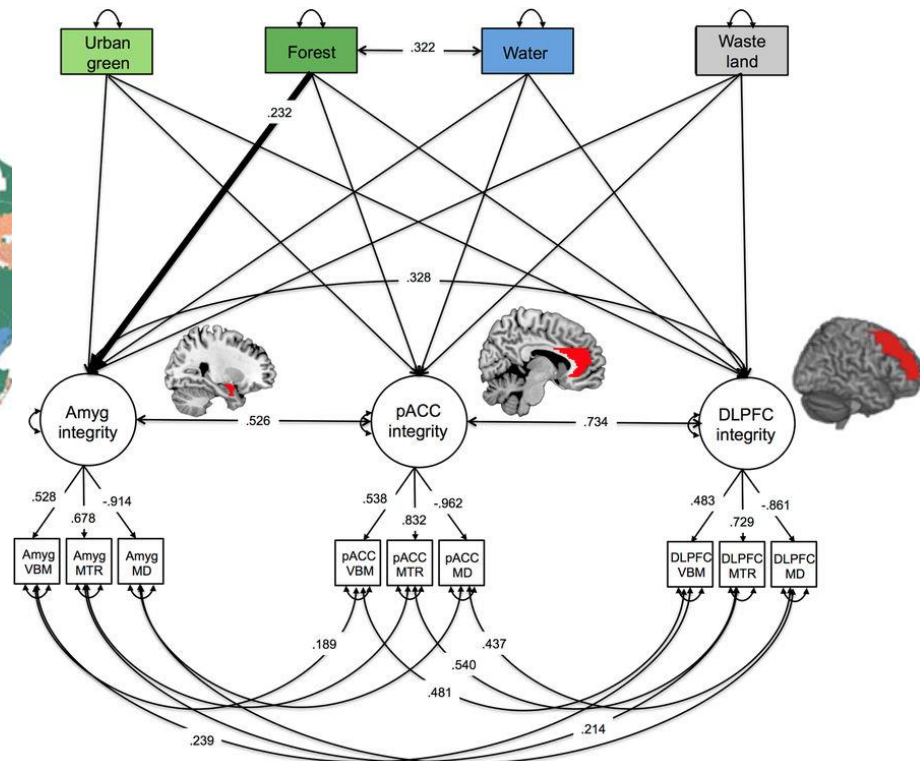
⇒住宅地の周辺に緑が多いと死亡率が低下する

# ② 森林との距離と脳機能



人間は森林の近くに生きていた方が幸せになる。  
森林の近くに住む人は健康な扁桃体をもつことが明らかに。

(n=341)



In search of features that constitute an “enriched environment” in humans: Associations between geographical properties and brain structure

Simone Kühn, et al., Scientific Reports volume 7, Article number: 11920 (2017)



# ダイバーシティ化する評価研究



1. 場所: 森林→都市のみどり



2. 対象: 健常者→罹患者・鬱病・トラウマの治療

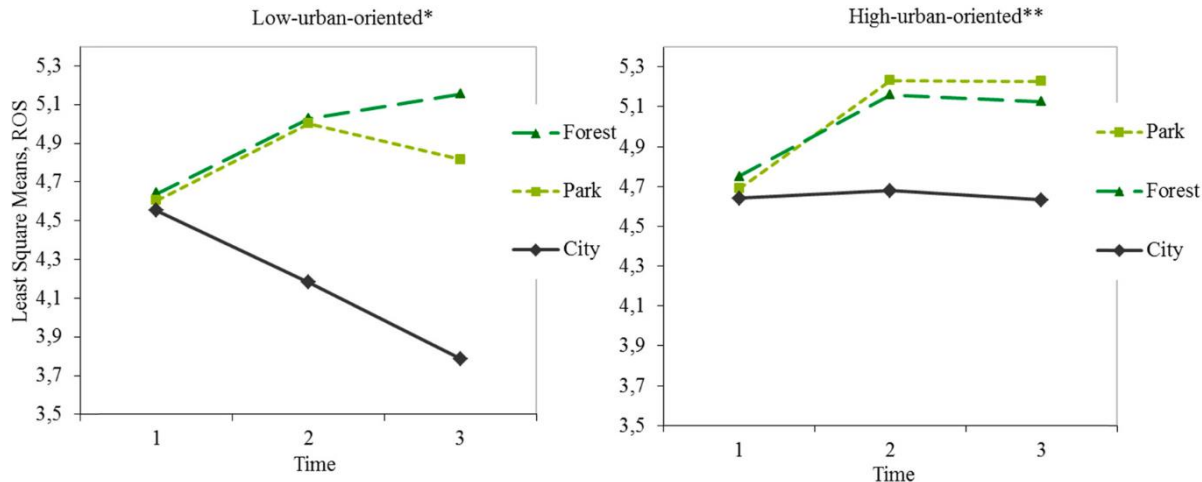


3. 内容: 心身への影響→幸福感等との関係



4. 主・客: 人間の効果→環境の設計

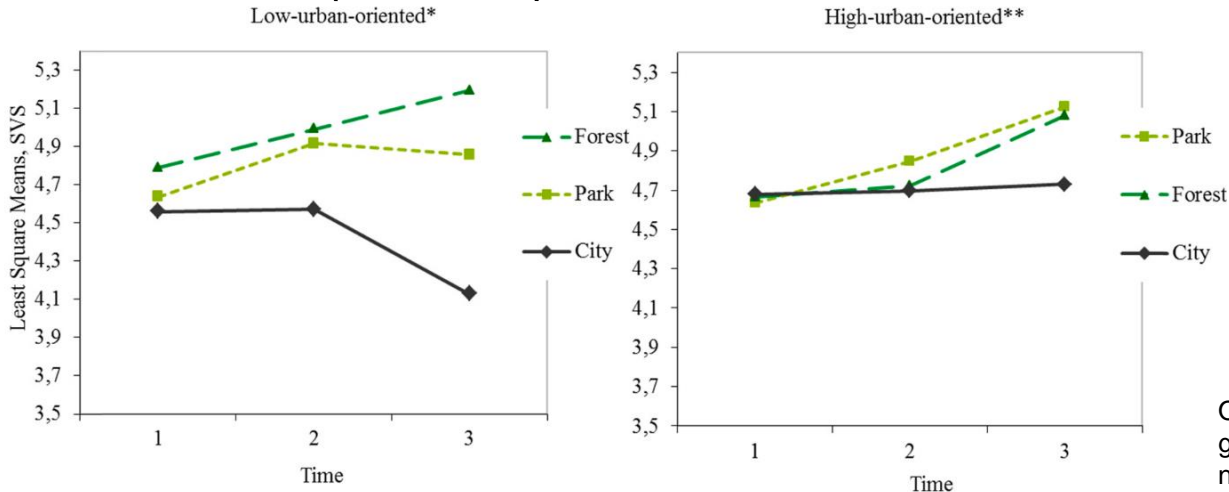
# 1. 都市のみどり



\* Interaction significant

\*\* Interaction not significant; of the main effects Env. and Time significant

## 図 ROS(回復感)による比較結果(上)



\* Interaction significant

\*\* Interaction not significant; of the main effects Time significant

## 図 SVS(活力感)による比較結果(下)



Fig. 2. Viewing session in Helsinki city centre.



Fig. 3. Walking session in Alppipuisto (urban park).



Fig. 4. Completing questionnaires in Keskuspuisto (urban woodland).

Ojala A., et al., Restorative effects of urban green environments and the role of urban-nature orientedness and noise sensitivity: A field experiment, *Health and Place* 55 (2019) 59–70.

n=80

# 1. 都市のみどり

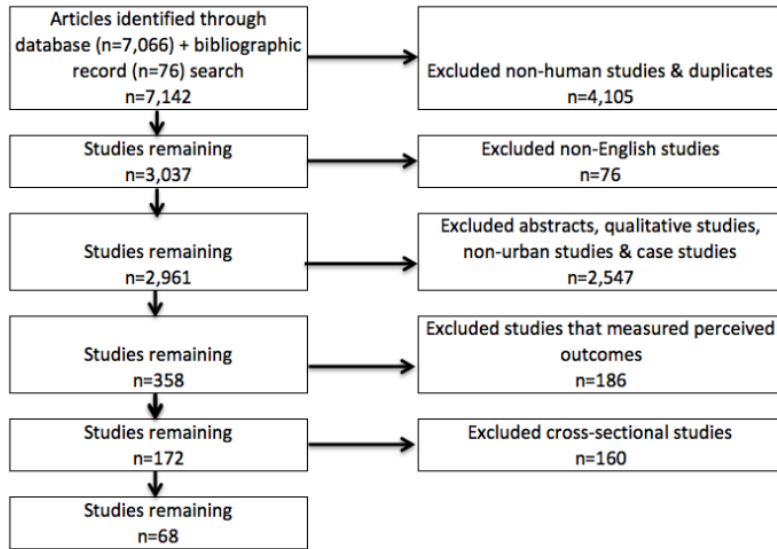


Figure 1. Article Selection Process.

Table 3. Health Outcome Measures with Study Paper Citations.

Health Outcome Measure	Citations	Health Outcome Measure	Citations
<b>Behavior</b>		<b>Metabolic</b>	
Behavioral problems	[33]	Abdominal obesity	[74]
Smoking	[78]	BMI	[22,24,48,51,57,78]
		Cortisol	[36,58,62,76,79]
<b>Birth Outcomes</b>		Diabetes	[74]
Birth weight	[39]	Prediabetes	[74]
Preterm birth	[39]		
Small for gestational age	[39]	<b>Mortality</b>	
		Acute ischemic stroke	[45,51]
<b>Cancer</b>		Any/all cause	[45,68,72]
Prostate cancer	[66]	Cancer	[45]
		Diabetes	[45]

Table 3. Cont.

Health Outcome Measure	Citations	Health Outcome Measure	Citations
<b>Cardiovascular</b>		<b>Cardiovascular</b>	[41,65,78]
Autonomic function	[57]	Cerebrovascular	[65]
Blood pressure - hypertension	[13,36,74,78]	Infections and parasitic disease	[45]
		Ischemic/coronary artery disease	[45,65]
Cholesterol	[13,36,78]	Kidney	[45]
CVD risk	[57]	Neurodegenerative disease	[45]
Diastolic blood pressure	[43,57,76,77]	Respiratory	[45,65,68]
Dyslipidaemia	[74]		
Heart rate (HR)	[43,50,57,69-71,76,77]	<b>Physical Activity</b>	
Heart rate recovery	[77]	Cycling frequency	[20]
Heart rate variability-ln(HF)	[57,58,69-71]	Exercise duration	[77]
Heart rate variability-ln(LF)	[58]	Exercise frequency	[13] [60]
Heart rate variability-ln(LF/HF)	[58,69-71]	MVPA	[21,23,25-29,31,32,34,52,59]
Heart rate variability-percent coefficient of component variance	[58]	Physical activity—duration	[78]
Peak diastolic blood pressure (DBP) during exercise	[77]	Taking up cycling for transport	[73]
Peak heart rate	[77]	Walking frequency	[20,42,61,75]
Peak systolic blood pressure (SBP) during exercise	[77]	Work load	[77]
Predicted aerobic fitness	[57]	Physical Health	
Pulse wave velocity	[77]	Physical health	[57]
Systolic blood pressure	[43,57,76,77]	Predicted aerobic fitness	[57]
<b>Mental Health</b>		<b>Mental Health</b>	
Anger	[38,43,69,70]	Sadness	[43]
Anxiety	[38,64,71]	Satisfaction	[60]
Anxious	[44]	Self-esteem	[56]
Attention	[17,46,47,58,79]	Stress	[13,36,64]
Attentiveness	[43]	Subgenual prefrontal cortex activation	[37]
Calm	[44]	Tired	[44]
Confusion	[38,69,70]	Total mood disturbance	[56]
Depression	[20,38,49,64,69,70]	Vigor	[38,69,70]
Elevating experience	[64]	Social capital	
Emotions	[38,54,71]	Sense of community	[49]
Energy	[44]		
Fatigue	[38,69,70]	<b>Violence-Aggression</b>	
Fear	[43]	Aggression	[35]
General health	[51,55,57,61,78]	Drug crimes	[13,16,36]
Happiness	[43]	Gun assault	[30]
Life functioning	[46,47]	Nuisance crimes	[13,16,36]
Mental health	[53,57]	Perceived safety	[40]
Motivation	[67]	Property crime	[14,16,36]
Nature connectedness	[67]	Violent crime	[13,14,16,36]
Negative affect	[47,62,64,67,76]		
Positive affect	[43,47,62,64,67,76]	<b>Respiratory</b>	
Quality of life	[78]	Aeroallergen Sensitization	[18]
Restoration	[36,58,79,80]	Allergic rhinitis	[18]
Rumination	[37,38]	Ear and nose symptoms	[18]

⇒都市のみどりと回復効果についての研究には既にこれだけの蓄積がある

# 2. 森林浴とうつ病

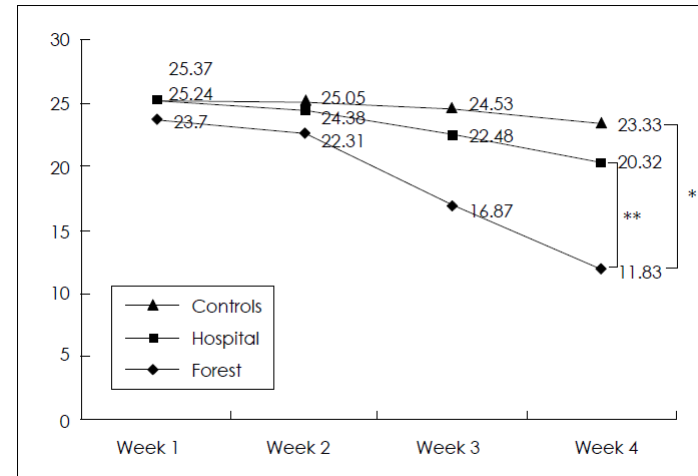
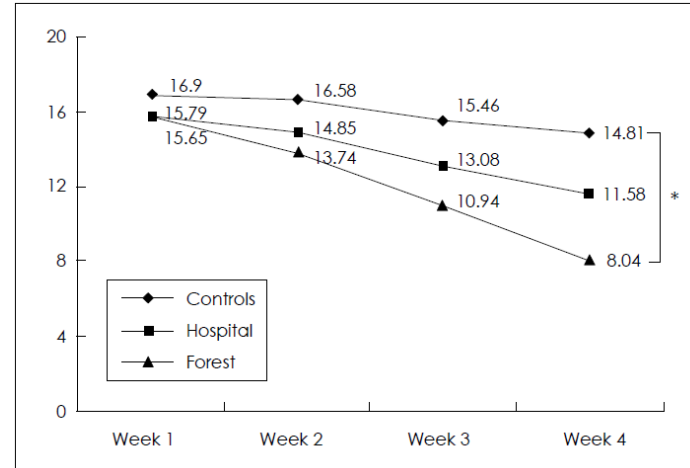
(n=20)

Measure	Walk Location	Pre-Mood Induction	Post-Mood Induction	Post-Walk
BDS	Nature	7.42 (3.00)	n/a	8.63 (2.87)
	Urban	8.26 (2.51)	n/a	7.84 (2.24)
BDS (1 participant removed)	Nature	7.72 (2.78)	n/a	8.83 (2.81)
	Urban	8.33 (2.57)	n/a	7.94 (2.26)
Positive Affect	Nature	2.11 (0.82)	1.48 (0.55)	2.62 (1.03)
	Urban	1.92 (0.62)	1.52 (0.44)	2.26 (0.89)
Negative Affect	Nature	2.04 (0.84)	2.41 (0.96)	1.53 (0.86)
	Urban	2.03 (0.88)	2.58 (1.06)	1.64 (0.92)



⇒森林浴によってうつ病患者の鬱症状が緩和した

(n=73)

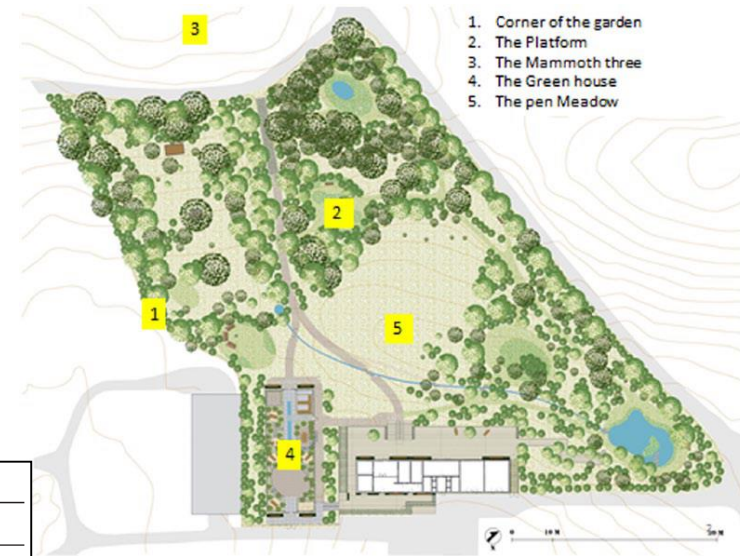
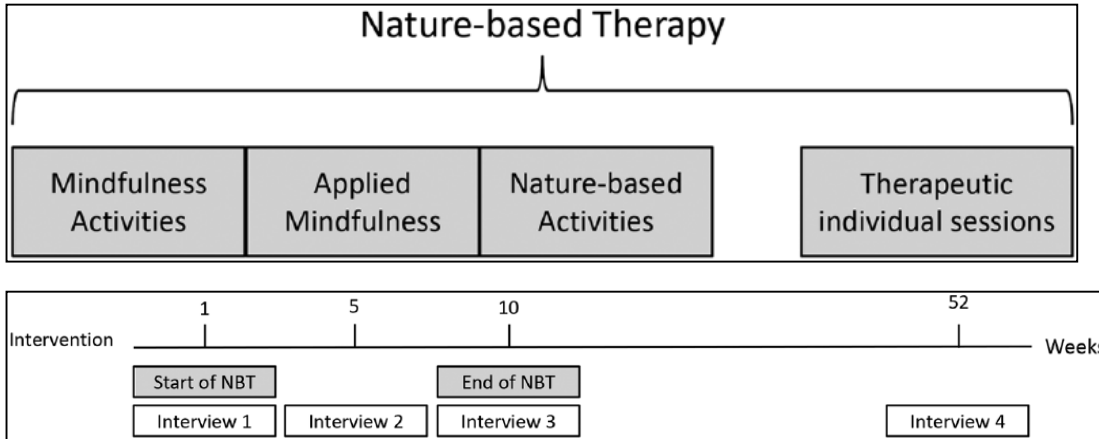


- 1) Berman, M. G., Kross, E., Krpan, K. M., Askren, M. K., Burson, A., Deldin, P. J., ... & Jonides, J. (2012). Interacting with nature improves cognition and affect for individuals with depression. *Journal of affective disorders*, 140(3), 300-305.
- 2) Kim, W., Lim, S. K., Chung, E. J., & Woo, J. M. (2009). The effect of cognitive behavior therapy-based psychotherapy applied in a forest environment on physiological changes and remission of major depressive disorder. *Psychiatry investigation*, 6(4), 245.



# 2. 森林浴とトラウマ

(n=8)



**Table 1.** An overview of the superordinate themes and the corresponding subthemes.

Superordinate themes	Subthemes
Taking nature in NBA as an initiator to a therapeutic process	Finding the places that feels right Meaningfulness by doing things in and with nature
Nature as a part of a life with PTSD	Transferability of features from the therapy garden to one's own environment
Sensing the nature	The therapeutic settings of NBA
Nature seems inclusive	Knowledge increases fascination about nature
Getting things done by oneself	

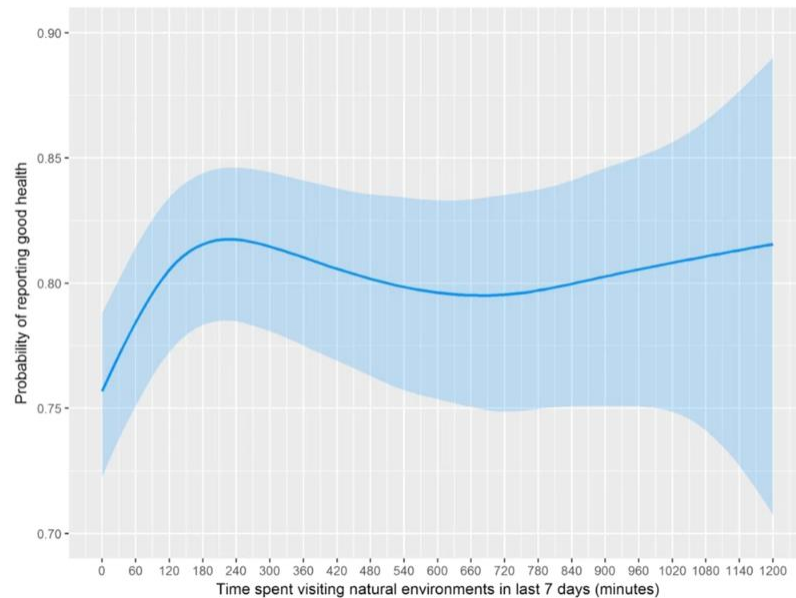
⇒ 森林浴によって、事後だけでなく  
継続的なトラウマの改善がみられた  
(質的研究)

Poulsen, D. V., Stigsdotter, U. K., Djernis, D., & Sidenius, U. (2016). 'Everything just seems much more right in nature': How veterans with post-traumatic stress disorder experience nature-based activities in a forest therapy garden. *Health psychology open*, 3(1), 2055102916637090.

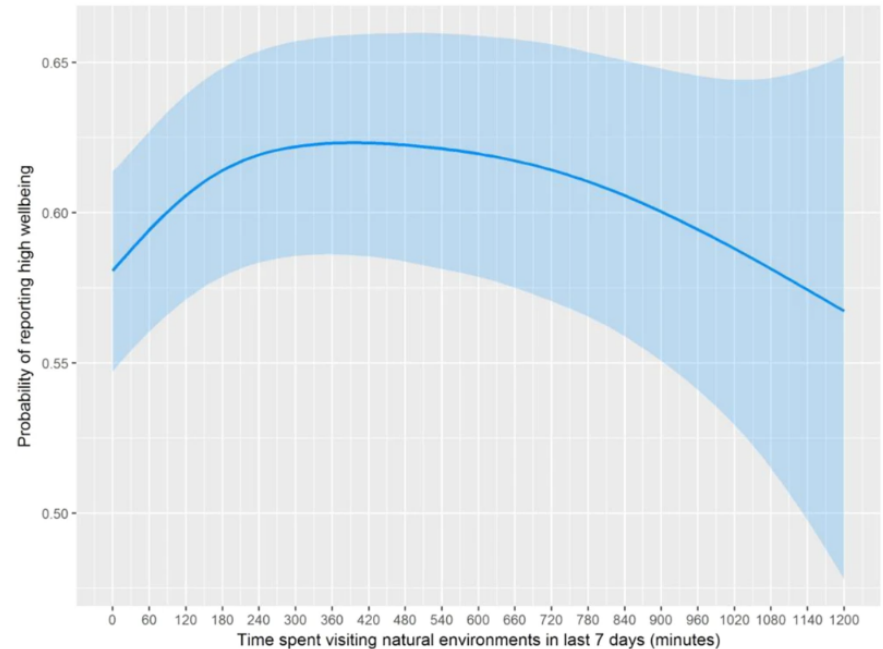
# 3. 森林浴と幸福感等

## 健康感

From: Spending at least 120 minutes a week in nature is associated with good health and wellbeing



## 幸福感



The probability of reporting (a) good health and (b) high well-being (with 95% confidence intervals) as a function of time spent in nature in the last 7 days using a generalised additive model (GAM) with a penalized cubic spline for nature contact. Note. The GAM is adjusted for urbanicity, neighbourhood greenspace, area deprivation, background PM10, sex, age, SES, restricted functioning, physical activity, employment status, relationship status, ethnicity, children in household, dog ownership and year.

過去一週間に2時間以上自然環境にふれた人は、そうでない人に比べ、  
健康状態や幸福感が良好。効果は6時間で最大。

n=約20,000

White, M.P.; Alcock, I.; Grellier, J.; Wheeler, B.W.; Hartig, T.; Warber, S.L.; Bone, A.; Depledge, M.H.; Fleming, L.E. Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Sci. Rep.* 2019, 9, 7730.

# 4. 森林環境の設計

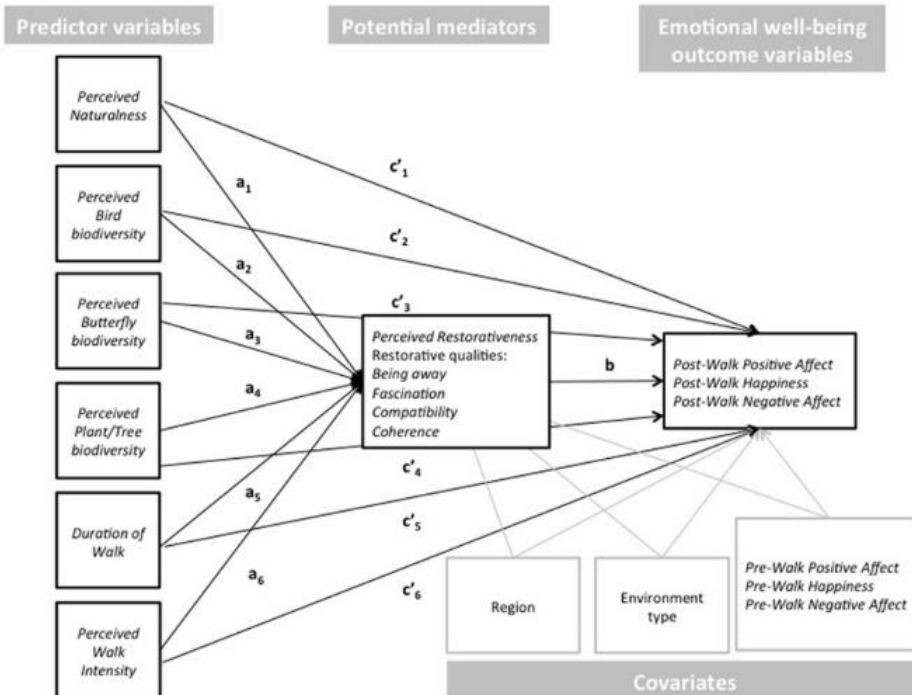
1) 表 回復効果をもたらす環境の特性(回復特性)の比較 (n=46)

	Setting	Being away	Fascination	Coherence	Scope	Compatibility	Familiarity	Preference
Ave.	Forest	34.5	32	22.4	27.5	28.2	3.4	10.9
	Urban (Control)	20.8	27.1	21.2	18.8	23.5	5.4	7.7
S.D.	Forest	12.5	9.8	7	9.2	8	2.9	4.7
	Urban (Control)	13.6	10.3	8.7	8.6	6.6	2.7	4.1
<i>p</i> value		0.000	0.033	0.101	0.000	0.003	0.001	0.001
Significance		**	-	-	**	*	**	**
effect size: <i>r</i>		0.568	0.335	0.204	0.610	0.441	0.487	0.519
statistical power: $\beta$		0.975	0.910	0.148	0.993	0.922	0.853	0.952

Ave. = Average; S.D. = Standard Deviation; *p* values from paired t-test (After applying Bonferroni's correction).  
Paired t-test significance levels: \*\*  $p < 0.00143$ , \*  $p < 0.00714$ , -  $p > 0.00714$ .

1) Takayama N, Morikawa T, Bielinis, Relation between Psychological Restorativeness and Lifestyle, Quality of Life, Resilience, and Stress-Coping in Forest Settings., International journal of environmental research and public health 16(8) 2019.4.

2) Marselle, Melissa R., et al. "Does perceived restorativeness mediate the effects of perceived biodiversity and perceived naturalness on emotional well-being following group walks in nature?." Journal of Environmental Psychology 46 (2016): 217-232.



(n=127)

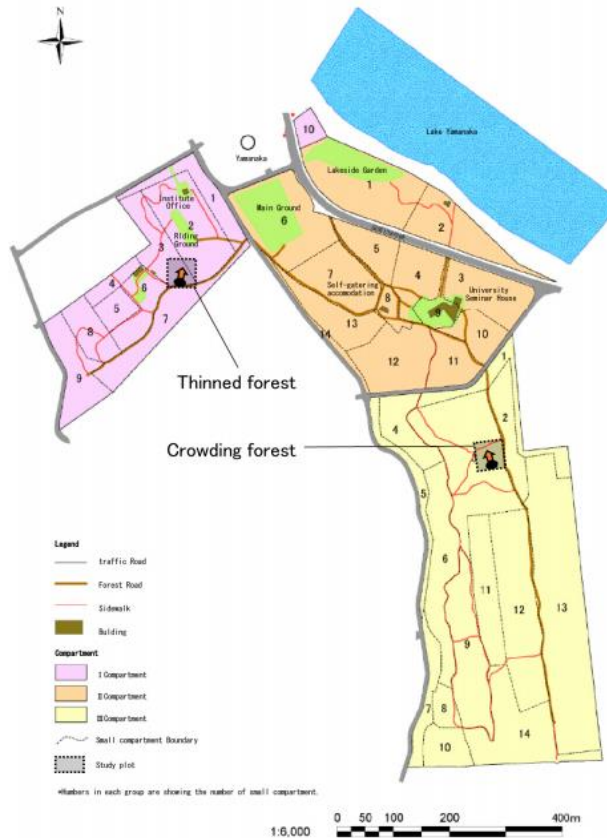
ヨーロッパを中心に、環境の有する回復特性を測定する尺度=PRS (Perceived Restorativeness Scale)を用いて、どうしたら回復効果の高い環境の整備が可能になるのかについての検討がなされている。

むしろ、ヨーロッパでは森林浴の効果をも与えるものとして、さらに高度に発揮させるためのエビデンスを強く求めているように思われる

2) 図 回復特性と物理環境・行動との因果関係の整理



# 4. 森林環境の設計



	Crowding Forest	Thinned Forest	
Stand density (number/ha)	1212 (n = 303)	1056 (n = 251)	
Stand basal area (m <sup>2</sup> /ha)	32.7	44.3	
Species composition (basal area; %)	Larch	66.5%	66.3%
	Dogwood	7.0%	10.1%
	Red pine	7.3%	7.3%
	Fir	0.0%	6.4%
	Japanese-alder	0.0%	1.8%
	Veitch's silver fir	0.4%	1.8%
	Fuji cherry	0.3%	0.8%
	Maple	2.1%	0.6%
	Japanese wing nut	0.0%	0.6%
	Others	16.4%	4%

Hemispherical photograph



Scenery



下草が繁茂した未間伐の森林を間伐すると、

- ・間伐林では風景評価は劇的に改善する。
- ・回復効果については未間伐林も間伐林も心身が回復する。
- ・しかし、間伐林の方がよりその回復効果が高い。

n=17

1) Management Effectiveness of Secondary Coniferous Forest for Landscape Appreciation and Psychological Restoration

Norimasa Takayama, Akio Fujiwara, Haruo Saito, Masahiro Horiuchi  
International Journal of Environmental Research and Public Health 14(7) Jul 2017

2) Effects of managed forest versus unmanaged forest on physiological restoration from a stress stimulus, and the relationship with individual traits

Saito Haruo, Horiuchi Masahiro, Takayama Norimasa, Fujiwara Akio

JOURNAL OF FOREST RESEARCH 24(2) 77-85 Mar 2019

# 先行研究の収集・整理の方向性(案)

- 心と身体の健康づくりは、手法・要素等を分けながら先行研究などを整理
- 今年度については、時間・労力の問題から関連論文等を網羅するのは困難のため、レビュー論文を参考にして再整理。不足部分は個別論文に当たる。
- データベースの候補
  - ・Pubmed・CINAHL・PsycINFO・SCOPUS(英文)
  - ・Cinii・J-stage(日本語)                      ・Mendeley・他
- テレワーク、社員研修、福利厚生・CSR等は、森林を活用した取組の先行研究はあまりない。
  - ・ 類似分野の先行研究と、具体的な森林での取組事例等から、今後の研究課題を整理するイメージ。
  - ・ 専門部会内外で、他に情報収集している研究者等との連携も必要。
- 英文(海外・国内)の研究とともに、日本語(国内)の研究も、どういう母集団からピックアップするかも検討が必要。
- エビデンスをまとめつつ、レセプトデータ分析・解析により理解を進めていくことが大事。